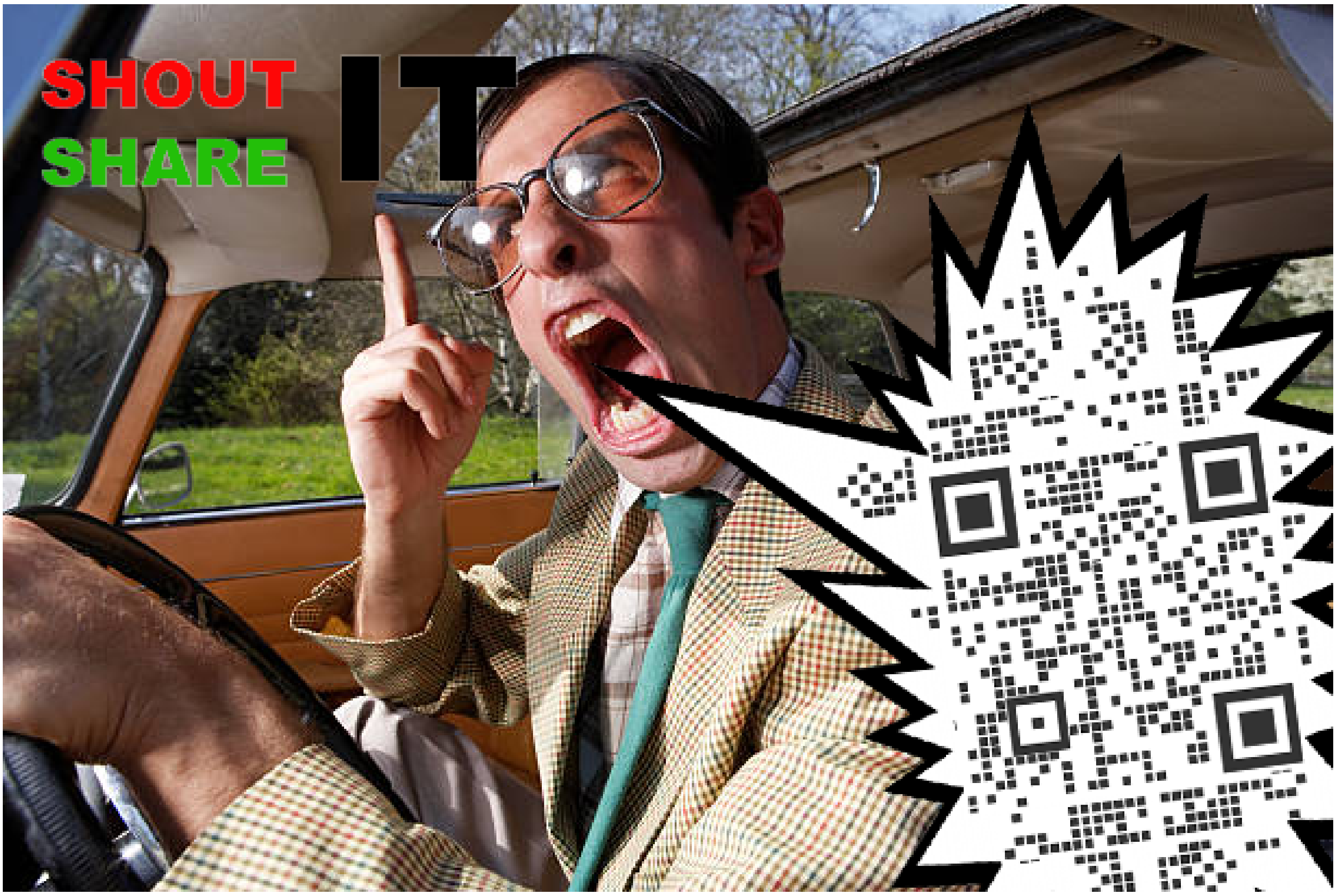
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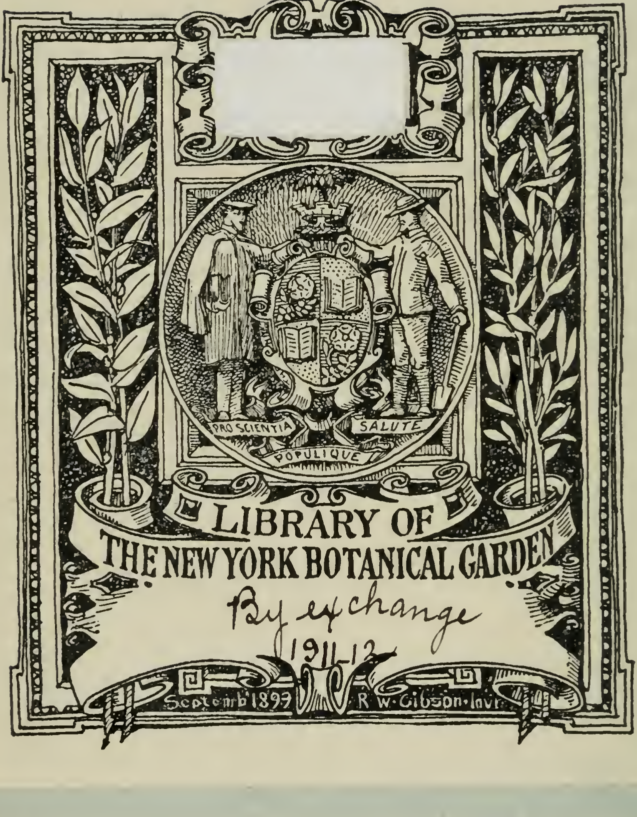
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# GUIDE

TO THE

# INSECTS OF CONNECTICUT

PREPARED UNDER THE DIRECTION OF

WILTON EVERETT BRITTON, Ph. D.,
State Entomologist, and Entomologist of the Connecticut Agricultural Experiment Station.

## PART I

## GENERAL INTRODUCTION

By
WILTON EVERETT BRITTON

## PART II

## THE EUPLEXOPTERA AND ORTHOPTERA OF CONNECTICUT

By
BENJAMIN HOVEY WALDEN, B. Agr.,
Assistant in Entomology, Connecticut Agricultural Experiment Station.

.U8842
#16-21

# BULLETINS

OF THE

# State Geological and Natural History Survey of Connecticut.

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1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.

2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn. [Out of print.]

3. A Preliminary Report of the Hymeniales of Connecticut: by Edward Albert White. [Out of print.]

4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.

5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.

6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.

7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory and Henry Hollister Robinson.

8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.

9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.

10. A preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn and Lucia Washburn (Hazen) Webster.

11. The Bryophytes of Connecticut: by Alexander William Evans and George Elwood Nichols.

12. Third Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1907-1908.

13. The Lithology of Connecticut: by Joseph Barrell and Gerald Francis Loughlin.

14. Catalogue of the Flowering Plants and Ferns of Connecticut growing without cultivation: by a Committee of the Connecticut Botanical Society.

15. Second Report on the Hymeniales of Connecticut: by Edward Albert White.

16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part I. General Introduction: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

Bulletins 1, 9, 12, and 17 are merely adimnistrative reports, containing no scientific matter. The other bulletins may be classified as follows:

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# CATALOGUE SLIPS.

**Connecticut.** *State geological and natural history survey*

Bulletin No. 16. Guide to the insects of Connecticut. Prepared under the direction of W. E. Britton. Part I. General introduction. By W. E. Britton. Part II. The euplexoptera and orthoptera of Connecticut. By B. H. Walden. Hartford, 1911.

169 pp., 11 pls., 66 figs. (1 map), $23^{cm}$.

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***Britton, Wilton Everett.***

Guide to the insects of Connecticut. Prepared under the direction of Wilton Everett Britton. Part I. General introduction. By Wilton Everett Britton. Part II. The euplexoptera and orthoptera of Connecticut. By Benjamin Hovey Walden. Hartford, 1911.

169 pp., 11 pls., 66 figs. (1 map), $23^{cm}$.

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# CATALOGUE SLIPS.

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169 pp., 11 pls., 66 figs. (1 map), 23$^{cm}$.

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169 pp., 11 pls., 66 figs. (1 map), 23$^{cm}$.

(Bulletin no. 16, Connecticut geological and natural history survey.)

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# CATALOGUE SLIPS.

*Insects.*

Britton, W. E., and Walden, B. H. Guide to the insects of Connecticut. Prepared under the direction of W. E. Britton. Part I. General introduction. By W. E. Britton. Part II. The euplexoptera and orthoptera of Connecticut. By B. H. Walden. Hartford, 1911.

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## PART I

# General Introduction

BY

WILTON EVERETT BRITTON

# GUIDE TO THE INSECTS OF CONNECTICUT.

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## PART I. GENERAL INTRODUCTION.

The present paper is the first of a series dealing with insects, in which it is expected that ultimately the whole subject may be treated. The desirability of a published guide to the insects occurring within the boundaries of the state is beyond question; and this should include such notes regarding their characters, distribution, and habits as may prove helpful in recognizing them, so that if harmful they may be combated, or if beneficial they may be encouraged. It is impossible at the present time to prepare any accurate account of the species of all orders of insects found in Connecticut, because little attention has been given to some groups, and collections have not yet been made. Probably the most feasible plan will be to take up separately the insects in each order, or in some cases a single family may become the subject of a separate bulletin. Those groups which have received the most attention by collectors and students will naturally be the first to receive treatment; but the work must be regarded as preliminary, as it will require the efforts of many years to make it even approximately complete in all particulars.

The authority for including certain species of insects as occurring within the boundaries of the state is based upon Connecticut material in the insect collection of the Agricultural Experiment Station at New Haven. The material has been accumulating for sixteen years, though the chief portion of it has been collected during the past nine years. Other important collections are those of the United States National Museum, Washington; American Entomological Society, Philadelphia; American Museum of Natural History, New York; Museum of Comparative Zoölogy, Cambridge, Mass.; Boston Society of

Natural History, Boston; and Peabody Museum of Yale University, New Haven: all of which contain more or less material from Connecticut, the records from which have been freely used. Many private collections will probably be mentioned in the separate accounts of the orders.

It is well-nigh impossible for such a work as is here projected to be accurately carried out by any one person. The aid of specialists will therefore be invoked, in the belief that their coöperation will make the work much more complete and accurate than would be possible otherwise. Full credit will be given for such assistance.

## BIBLIOGRAPHY OF THE MORE IMPORTANT WORKS RELATING TO NORTH AMERICAN ENTOMOLOGY.

### *General.*

Manual for the Study of Insects, by J. H. and A. B. Comstock. vii + 701 pages, 6 plates, 797 figures. Comstock Publishing Co., Ithaca, N. Y. 1895.

Guide to the Study of Insects, by A. S. Packard. x + 715 pages, 15 plates, 668 figures. Henry Holt & Co., New York. Ninth edition, 1889.

The Insect Book, by L. O. Howard. xxvii + 429 pages, 48 plates, 264 figures. Doubleday, Page & Co., New York. 1901. Contains bibliography and many colored plates.

American Insects, by V. L. Kellogg. vii + 674 pages, 13 plates, 812 figures. Henry Holt & Co., New York. 1905.

Text-Book of Entomology, by A. S. Packard. xvii + 729 pages, 654 figures. The Macmillan Co., New York. 1898. Especially devoted to structure and physiology, and contains bibliography.

Entomology with Special Reference to its Biological and Economic Aspects, by J. W. Folsom. vii + 485 pages, 5 plates, 300 figures. P. Blakiston's Son & Co., Philadelphia, 1906. Especially devoted to structure and development, and contains bibliography.

American Entomology, by Thomas Say. 2 volumes. 54 plates, 412 + 814 pages. Le Conte edition, 1869.

Elements of Insect Anatomy, by J. H. Comstock and V. L. Kellogg. 145 pages, 11 figures. Comstock Publishing Co., Ithaca, N. Y. Third edition, 1901.

Insects of New Jersey, by J. B. Smith. 755 pages, 329 figures. New Jersey State Board of Agriculture. 1899. An annotated and illustrated list of the insects of the state.

Explanation of Terms Used in Entomology, by J. B. Smith. vii + 154 pages, 4 plates. Published by the Brooklyn Entomological Society, Brooklyn, N. Y. 1906.

### *Journals.*

Canadian Entomologist (monthly), Volumes 1-40, 1869-date. London, Ontario, Canada.

Entomological News (ten numbers annually), Volumes 1-19, 1890-date. Academy of Natural Sciences, Philadelphia, Pa.

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Reports of Ontario Entomological Society. 38 volumes, 1870-date. Index volumes 1-30. Published by the Ontario Department of Agriculture.

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### *Economic.*

Insects Injurious to Vegetation, by T. W. Harris. xi + 640 pages, 8 plates, 278 figures. Crosby & Nichols, Boston. Flint edition, 1863.

Economic Entomology, by J. B. Smith. xii + 481 pages, 483 figures. J. B. Lippincott Co., Philadelphia. 1896.

Our Insect Friends and Enemies, by J. B. Smith. 314 pages, 121 figures. J. B. Lippincott Co., Philadelphia. 1909.

Insects Injurious to Fruits, by W. Saunders. 436 pages, 440 figures. J. B. Lippincott Co., Philadelphia. Second edition, 1900.

Insects and Insecticides, by C. M. Weed. 334 pages. Orange Judd Co., New York.

Injurious Insects and the Use of Insecticides, by F. W. Sempers. x + 216 pages, 184 figures. W. Atlee Burpee & Co., Phila. 1894.

Insects Injurious to Staple Crops, by E. D. Sanderson. x + 295 pages, 162 figures. John Wiley & Sons, New York. 1902.

Insects Injurious to Vegetables, by F. H. Chittenden. xiv + 262 pages, 163 figures, bibliography. Orange Judd Co., New York. 1907.

Bibliography of Economic Entomology, by S. Henshaw and N. Banks. Parts 1-8, 1890-1905. Published by U. S. Department of Agriculture, Washington, D. C.

Reports on the Noxious, Beneficial, and Other Insects of Missouri, by C. V. Riley, 1-9 with index, 1869-1877.

United States Entomological Commission, Reports 1-5, 1877-1890. Published by the U. S. Department of Agriculture, Washington, D. C.

Insect Life. 7 volumes with index. Published periodically by the U. S. Department of Agriculture, Washington, D. C. 1888-1895.

Bulletins 1-33; N. S., 1-89, Bureau of Entomology: 1895-date. Index volumes 1-30. Bulls. 24 and 81 contain bibliography. Also Circulars 1-96, Technical Bulletins 1-14, and Farmers' Bulletins. Published by U. S. Department of Agriculture, Washington, D. C.

Noxious Insects of New York, by A. Fitch, Reports 1-14. Published by the New York Agricultural Society. 1856-1870.

Reports of State Entomologist of New York. 22 Volumes. 1-13 by J. A. Lintner, 13-22 by E. P. Felt. 1882-date.

Reports on Insects of Illinois. 23 volumes. Vol. 1 by B. D. Walsh, 1867. 2-5 by Wm. Le Baron, 1868-1874. 6-9 by C. Thomas, 1875-1880. 10-22 by S. A. Forbes, 1880-1905.

Reports and Bulletins of the State Agricultural Experiment Stations contain much entomological matter. The publications of the Connecticut Station at New Haven contain the nine reports of the State Entomologist (1901-1909) which deal with Connecticut insects.

Journal of Economic Entomology (bi-monthly, started in 1908). Official organ of the Association of Economic Entomologists, containing the proceedings of the association. (Previously the proceedings were printed in Insect Life, and as Bulletins of the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.)

The publications here listed do not include those of a special nature such as the monographs of separate orders or families of insects. These will doubtless be listed in the future publications referring to the various groups. Any one wishing to learn about these special lists and monographic papers may consult the bibliographies in Howard's Insect Book and in Bulletins 24 and 81 of the Bureau of Entomology.

## ABUNDANCE OF INSECTS.

Insects are of small size, and are among the most abundant of animals. Not only are the individuals very numerous, but the number of species is probably greater than that of all other land animals. About 400,000 species have been described throughout the world, and it has been estimated that several million species exist. For a given locality the number of species is much less, yet some parts of the world are almost wholly unexplored as regards insect life. The number of species that occur in Connecticut is of course much smaller than that of the whole continent, and may be expected to aggregate between 6,000 and 10,000.

Though found all over the earth, even in the arctic regions, insects are most abundant in the tropics. It is here also that we find the largest and most brilliantly colored species. But some of our own species are no less interesting, if less gorgeous.

### HABITS AND HAUNTS OF INSECTS.

Most species of insects are terrestrial, though many forms are aquatic, the familiar examples being water bugs and water beetles. Certain other insects, like dragon-flies, caddis-flies, stone-flies, may-flies, mosquitoes, and some other Diptera, are aquatic during the larval stage, but fly about in the air as adults.

A large proportion of the various kinds of insects feed upon living plant tissues, either destroying the foliage, or boring in the wood of the stem, root, or branches. Others live in the soil and devour small roots of trees and plants. Dead and decaying plant tissues also form the food of a large number of species, and such conditions are found chiefly in connection with the soil. We find also in the soil certain other kinds that do not eat plant tissues, but feed upon the animal life therein; such insects preying upon other living forms are said to be predaceous or predatory, and may attack other kinds of insects or perhaps certain other small animals. Beetles of the family Carabidæ are a good example, though some kinds are not always found in the soil, but frequent trees and fly about in the air in search of their prey. Some of the two-winged flies (order Diptera) and hornets (order Hymenoptera) have the same habit. Beetles of the families Silphidæ and Staphylinidæ are known as carrion beetles, and, in company with two-winged flies known as carrion flies, are found about dead animals of all kinds. The beetles feed upon the decaying animal matter, and the flies breed therein, their larvæ feeding upon it.

A host of the insects are animal parasites. The biting lice or bird lice (order Mallophaga) and the sucking lice of mammals (order Hemiptera) are small insects, mostly light colored or transparent, feeding upon the blood or skin of the host, and frequenting the most protected parts of the body, where they crawl about among the hairs. Other parasites of a similar nature are the sheep ticks (order Diptera) and fleas (order

Siphonaptera). The bot-flies (order Diptera) are internal parasites, the eggs being laid upon hairs and taken into the stomach of the host through the mouth; the larval stage is passed in the host.

Many four-winged flies (order Hymenoptera) and two-winged flies (order Diptera) are parasitic upon other insects. The egg is usually laid on or in the body of the larva of the host; and, after hatching, the young grubs or maggots feed therein until ready to transform, the host usually living just long enough to mature the parasites. By far the greater part of these insects are of small size and belong to a group commonly known as parasitic Hymenoptera.

In nature we find a balance between host and parasite. A certain species may, on account of abundance of food, become prevalent, and, if parasites are scarce, it will increase in numbers rapidly; but, when it becomes prevalent, it in turn furnishes for the parasites an abundant supply of food, which, other things being equal, enables them to multiply rapidly and soon overtake their host in point of numbers and finally subdue it. The host will then be scarce for a period, and on account of lack of food the parasites must of necessity be kept in check until again the host becomes abundant, when a corresponding increase in parasites will follow. Thus host and parasites play a veritable game of see-saw with each other in scarcity and abundance. Under these conditions no species is allowed to dominate the earth, but in the long run every species is kept in check by natural enemies.

The illustrations here given refer only to simple parasitism. In nature the case is usually much more complex, because the primary parasites are attacked by other parasites which are known as secondary parasites. The latter in turn may be parasitized by tertiary parasites, and so on. The term hyperparasite includes all except the primary parasite.

Nevertheless, in spite of the complexity, nature is able to preserve a sort of balance between her various organisms. It is only when nature's balance is disturbed that we find certain species overrunning the earth and crowding out others. Man has been the disturbing factor, by cutting off the forests and native vegetation, thus destroying food supply; by growing large areas devoted to a single crop; by carrying insects from one part of the world to another in connection with the transportation of products carried on by his commercial enterprise. Usually, when insects are transported to a new country, their parasites and other natural enemies are left behind; hence, when they become established, they are able to multiply with great rapidity, and often do much damage. Such has been the history of the gypsy moth, the elm-leaf beetle, the cabbage worm, the San José scale, and a score or more of other pests.

Some of the bees, wasps, and ants (order Hymenoptera) and the termites or white ants (order Neuroptera) are social in their habits, and live together in colonies, each colony occupying a nest. There is one queen in each colony, sometimes more than one, and the queen lays the eggs to increase the colony. In these communities of social insects the males are often called drones. Their function is to fertilize the queen; there are usually complemental females which are capable of reproduction in case the queen perishes. The great majority of the members of these colonies are called workers or neuters, but are really females imperfectly developed. They serve the community by feeding and caring for the young and by building the nests.

Most insects are not social, and do not live together in colonies, though many are gregarious to the extent that those hatching from a single egg-mass deposited by the female parent remain and feed together during a portion or the whole of their larval development. Many insects are solitary, and are not found together at all except perhaps when in search of food.

## DISTRIBUTION OF INSECTS, AND THE LIFE ZONES OF CONNECTICUT.

It has long been known that natural laws govern the distribution of native insects as well as of other animals and plants. For instance, we find vegetation on the mountain tops quite different from that growing in the valleys, and the flora of a desert in no wise resembles that of a swamp. In like manner we should expect to find faunal areas containing certain forms or species of insects which differ from the species occurring in other regions where the climatic conditions are different. Insects of the marsh along the coast are not the same as those of the high mountains, and those of the tropics are entirely different from those of the arctic regions. Thus latitude and altitude, as they affect temperature, and moisture or the lack of it, exercise important influences upon the distribution of insects.

In order to designate approximately the various natural areas of the United States in connection with the distribution of organisms, we speak of the Boreal, Austral, and Tropical regions. Each region is further divided into zones, beginning at the north, as follows: Arctic-Alpine zone, which is above the limit of tree growth; Hudsonian, extending from Labrador to Alaska, and including the northern portion of the great forests of spruce and fir; Canadian, comprising the southern portion of the coniferous forests, and the greater part of Canada, northern New England, the Adirondacks and high mountains of the Alleghanies, northern Michigan and Minnesota, and the higher parts of the Rocky Mountain region. The Transition zone is considered as marking the region where the Boreal and Austral elements overlap; and takes in most of the New England territory and the Alleghanian region, extending across the northern part of the United States, and includes also the greater portion of the Rocky Mountain region except the low valleys and deserts, which belong to the Austral, and the high mountains, which belong to the Canadian zone. The eastern portion of the Transition zone, which is humid, is often called the Alleghanian, in contradistinction to the more arid western or Pacific Coast Transition. The Upper Austral zone extends along the coast from Southern New England to Chesapeake Bay, and then southward each side of the mountain region and westward through the Central States and the valleys of the Rocky Mountain region. The eastern portion is often called the Carolinian zone. The Lower Austral extends from Chesapeake Bay along the coast to Mexico. and includes portions of Arizona and southern California.

Any one interested in these life zones, and the fauna, flora, and agricultural crops peculiar to each, should procure a copy of Dr. C. Hart Merriam's bulletin,* which explains the matter more fully and contains a map showing the extent of each zone. In order to show the relation of these zones to Connecticut, the accompanying map (see Fig. 1) has been adapted from Dr.

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*Life Zones and Crop Zones. Bulletin No. 10, Division of Biological Survey, U. S. Dept. of Agriculture, Washington, D. C., 1898.

Merriam's map, and references to these zones will be found in the forthcoming papers. The reader will notice that the Upper Austral extends over a narrow area along the coast and up the Connecticut River beyond the northern boundary of the state, and that the remaining portion is Transition. Very little field work has been done in Connecticut to establish the limits of these zones; but we find that certain species occur along the valleys of the Housatonic, Naugatuck, and Quinnipiac Rivers much farther north than the limits of the Austral zone as shown by the map. As these species do not occur in other Transition portions of the state, it is expected that the map must be modified considerably after further study of the plants and animals.

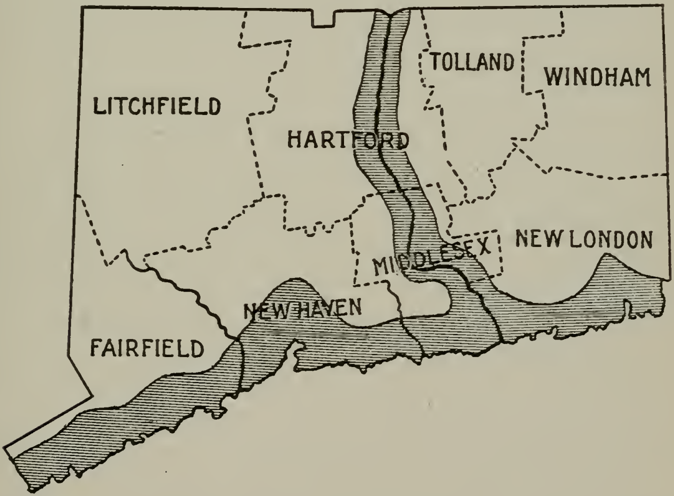


FIG. 1. Map of Connecticut showing the Life Zones in the State. The shaded portion represents the Upper Austral, and the unshaded portion the Transition. (Adapted from the map of Dr. C. Hart Merriam.)

## ECONOMIC STATUS OF INSECTS.

Man is accustomed to classify insects as injurious or beneficial to human interests. In general, people regard insects as being injurious, and give them little credit for the benefits which mankind derives from them. A few years ago Dr. L. O.

Howard, in an address before the Washington Biological Society, pointed out those families of insects which could be called distinctly injurious or distinctly beneficial, and found that they were about equally divided, as follows:

| | | |
|---|---|---|
| Injurious, . . | 116 | families. |
| Beneficial, . . | 113 | " |
| Both, or undetermined, | 71 | " |
| | 300 | " |

It will be seen at a glance, therefore, that there are about as many insects which are distinctly beneficial to man as there are which cause him injury. The great majority of insects are neither friends nor foes to man in any important degree, but each species fills a place perhaps no less important in relation to other organisms.

### *How Insects are Injurious.*

Insects are regarded as injurious if they destroy crops, like the potato beetle, and if, like the elm-leaf beetle, they attack highly prized shade trees, or, in fact, any other plant life which seems desirable to man. This is perhaps the most important injury caused by insects, and it has been estimated that fully one-tenth of all the agricultural crops of the United States, or a value of more than $700,000,000, is annually destroyed by insects. Methods of spraying and other forms of remedial treatment have been devised to prevent or check such destruction, and this phase of the subject has reached a higher development in the United States than elsewhere.

Certain kinds of insects also cause injury to stored foods, books, and clothes, and to dwelling houses. Other kinds attack live stock and other useful animals, and a few species annoy man. Recently it has been discovered that insects are more important as carriers of disease than was formerly supposed. Certain mosquitoes are the essential hosts of the malarial parasite, and it is only through their bites that these parasites are naturally transferred to man. Another kind likewise transmits yellow fever through its bites, and the disease called elephantiasis is transmitted to man by mosquito infection.

Germs of many intestinal diseases, like cholera and typhoid fever, and of other germ diseases, like bubonic plague and anthrax, are often carried mechanically on the feet or body of the common house fly, which breeds in and frequents foul matter, and then crawls over food. Both food and foul matter should be inaccessible to flies.

Certain gadflies are known to carry diseases of cattle.

### *Methods of Controlling Injurious Insects.*

The insect enemies of crops may be divided roughly into two classes: (1) those which bite or chew their food, and (2) those which suck out the plant juices for nourishment. To the former class belong those insects which devour portions of the plant, such as the borers, and all leaf-eating forms like the Colorado potato beetle, the elm-leaf beetle, canker-worms, the gypsy moth, and many others. The insects of the latter class, though less evident, are no less destructive, and include the San José and all other scale insects, and the aphids or plant lice.

Pests are commonly controlled by spraying, and by mechanical means such as traps, barriers, etc. Spraying with internal poisons is the best means of destroying the leaf-eating insects, and for this purpose Paris green and lead arsenate are used. The formulas are given herewith:

| *Lead Arsenate* | | *Paris Green* | |
|---|---|---|---|
| Lead arsenate | 3 lbs. | Paris green | 1 lb. |
| Water | 50 gals. | Lime | 3 lbs. |
| | | Water | 100 gals. |

Lead arsenate is manufactured in paste form, will adhere much longer to the foliage, remains better in suspension, and causes no injury to the foliage even when used in excessive quantities.

Paris green, on the other hand, is a dry powder, and may be mixed with land plaster or air-slaked lime and sifted upon the plants. It contains some free acid which is liable to injure foliage, settles quickly in water, and washes off easily. The addition of lime improves the sticking qualities, and neutralizes the free acid, and thus prevents injury to the foliage.

These poisons may be, and often are, used in Bordeaux mixture in orchard practice. Bordeaux mixture is a fungicide composed of copper sulphate and lime, and the lime being in excess prevents any injury occurring from the Paris green.

Hellebore acts as an internal poison and also as an external irritant, and is especially effective when used against the larvæ of sawflies, such as the imported currant worm. Hellebore may be used as a dry powder, or mixed with water in the ratio of one ounce to two gallons.

Sucking insects must be killed by other methods, as they insert their tiny beaks into the tissues and suck out the sap, and would not therefore obtain poison which was applied to the surface of the leaves.

It is necessary to destroy them by some application which on coming in direct contact with their bodies will kill, either by irritating or corroding them, or by stopping up their breathing pores and suffocating them. Various oil emulsions have the latter effect, and soap mixtures act in both ways, especially if they contain free potash. Kerosene emulsion may be made as follows:

| | |
|---|---|
| Kerosene | 2 gals. |
| Common soap | ½ lb. |
| Water | 1 gal. |

Dissolve the soap in hot water, add the kerosene, and churn together until a white, creamy mass is formed which thickens on cooling. Dilute with nine times the amount of water before using.

Common laundry soap dissolved in the ratio of one pound in eight gallons of water is an excellent contact insecticide, and is effective against most plant lice.

For several years the lime and sulphur mixture has been the chief remedy for trees infested by the San José scale insect, *Aspidiotus perniciosus* Comst.

*Lime and Sulphur Mixture*

| | |
|---|---|
| Fresh finishing lime | 20 lbs. |
| Fine sulphur flour | 14 lbs. |
| Water | 40 gals. |

Boil one hour, and apply while fresh to dormant trees.

The so-called "soluble" or miscible oils which are now being recommended instead of the lime and sulphur mixture, are really emulsions.

Insecticides are usually applied in the form of a spray, by means of a pump. In large orchards power sprayers are in vogue, but for smaller operations hand pumps are preferable. Advice regarding the most desirable forms of spraying apparatus may be obtained from any agricultural experiment station.

Other control methods consist in the use of poisoned bait, traps, sticky bands, hopper-dozers, and barriers, but these are for special use against certain kinds of insects. Crop rotation and cultural methods are practiced to forestall injury by certain species. Poisonous gases are also employed when they prove effective and inexpensive, — as in fumigating nursery stock and greenhouses with hydrocyanic acid gas to kill the San José scale, and in treating stored grain with carbon disulphide to kill the insects infesting it.

With certain other pests it is necessary to destroy their breeding places in order to control them. This is done in case of mosquitoes, certain kinds of which transmit yellow fever and malaria to man through their bites. It has recently been discovered that bubonic plague is transmitted to man through the bites of certain kinds of fleas which naturally live upon rats. The destruction of the rats is therefore the chief preventive measure in regions where this disease is prevalent.

### *How Insects are Beneficial.*

The greatest benefit which man derives from insects is through the part which insects play in plant pollination. A large proportion of plants, including some of the fruits and other cultivated crops, depend on insects to carry pollen from one plant to another. Without these insects there could be no crop. Insects aid man by destroying other insects and plants which are injurious or undesirable. To some extent they are scavengers and makers of soil, whereas to a large extent they serve as food for birds and fishes, and to a limited extent as food for man. Honey and beeswax are two important products of insects, and honey is an important addition to man's food. Wax and lac are used extensively in the arts, and silk is an extremely important material used as clothing. A large proportion of the food of poultry and song birds is composed of insects.

## CHARACTERS THAT DISTINGUISH INSECTS FROM OTHER ANIMALS.

Insects are articulated animals having six legs. They comprise the class *Hexapoda* (*Insecta*) of the phylum or branch *Arthropoda,* to which the spiders, centipedes, and crustacea also belong. Certain differences in structure may serve to distinguish insects from their allies, and some of these are set forth in the following table:

### Phylum **Arthropoda.**

Animals with a tough or hardened exterior, transversely segmented, and bilaterally symmetrical.

1. Respiration aërial, by tracheæ or lungs.............. 2
   Respiration aquatic, by gills or by the general integument; two pairs of antennæ; head and thorax usually consolidated ............................**Crustacea**
2. Head distinct ................................... 3
   Head and thorax united to form cephalothorax; abdomen distinct; antennæ wanting; eight legs..**Arachnida**
3. Head, thorax, and abdomen distinct; six legs and one pair of antennæ ..........................**Hexapoda**
   Thorax and abdomen not differentiated, formed of a large number of similar segments, each bearing one or two pairs of legs; one pair of antennæ....**Myriapoda**

Class **Hexapoda** or **Insecta** includes all of the insects — a class far more numerous in species than any other class of animals. Except in some specialized forms, all have six legs in the adult stage.

**Myriapoda.** Centipedes and millipedes, commonly known as thousand-legged worms. The large number of legs and the lack of differentiation of thorax and abdomen serve to distinguish this from other classes.

**Arachnida.** Spiders, mites, scorpions, and ticks. Though of some diversity of form, the lack of antennæ and the number of legs make it easy to recognize the members of this class.

**Crustacea.** Crayfish, lobsters, crabs, etc. Though some members of this class live out of water, they still breathe through gills or through the integument and live in moist places. The Crustacea have typically two pairs of antennæ. The highest and best-known group represented by crabs and lobsters have ten legs; but in the lower and less familiar groups the number of legs varies.

## EXTERNAL STRUCTURE OF INSECTS.

Generally speaking, all mature insects are covered with a hardened exoskeleton formed of chitin. This serves for the attachment of the muscles and for the protection of the vital organs. The trunk is divided into three more or less distinct regions; viz., head, thorax, and abdomen. Immature insects do not always show these divisions.

### *Head.*

The head bears the eyes, the mouth-parts, and the antennæ or feelers. The eyes of adult insects are usually compound; that is, made up of a large number of simple eyes placed close together, each having the form of a hexagon, and the whole resembling a piece of honeycomb. The simple eyes that go to form the compound eye are known as facets, and vary from about fifty in the eyes of certain ants, to nearly a thousand, as is the case with butterflies and dragon-flies. In addition to the compound eyes there are isolated simple eyes, called ocelli, often placed on the front of the head between the compound eyes.

A pair of jointed antennæ, usually situated between and in front of the compound eyes, serve as organs of touch. The antennæ vary greatly in size and shape in the different kinds of insects, some having antennæ which are filiform, some clavate, some feathery, etc. The antennæ of the sexes often differ, those of the male usually being more prominent.

The mouth-parts are fitted either for biting or for sucking. Biting mouth-parts consist of an upper lip (labrum) and an under lip (labium), between which are two pairs of jaws that move horizontally. The upper jaws are called mandibles, and are for tearing off the food; the lower jaws are known as maxillæ, and bear jointed appendages called maxillary palpi. The labium is furnished with jointed appendages called labial palpi.

Sucking mouth-parts consist of a jointed tube or proboscis through which the liquid is drawn, often containing needle-like organs called lancets for puncturing the tissues. The proboscis is formed by a modification of either the labium or the maxillæ.

The structure of the mouth-parts is of great importance, not only in classification but also in practical work with insects, as the application of insecticides depends upon the structure of the mouth-parts.

### *Thorax.*

The thorax is made up of three ring-like segments known respectively as pro-, meso-, and metathorax, and bears the organs of locomotion. Wings, when present, are borne dorsally by the meso- and metathorax, but one or both pairs may be absent. Flies have only the first pair of wings fitted for flight, the second pair being represented by a pair of knobbed threads, called *halteres* or balancers, the function of which is not well understood. In earwigs and beetles a pair of veinless horny wing covers takes the place of the first pair of wings. Grasshoppers, crickets, and locusts have a pair of closely veined, leathery fore wings which are used in flight.

The veins or nerves of the wings are designated by letters and numbers. The spaces between the veins are called cells, and are similarly designated. Wings of butterflies and moths are covered with scales, which give them their color patterns. Each segment of the thorax bears ventrally a pair of jointed legs; each leg consists of coxa, trochanter, femur, tibia, and tarsus. The tarsus is often many jointed and terminates in a claw.

### *Abdomen.*

The abdomen bears the organs of reproduction, and is made up of simple and distinct ring-like segments, varying in the different insects from three to nine in number. In the lowest order of insects, Thysanura, are found some forms with abdominal legs, but in no other adult insects are locomotive organs attached to the abdomen. In caterpillars and other larval forms fleshy appendages known as prolegs or false legs are borne upon the ventral surface of the abdomen.

The apex or distal extremity of the abdomen is furnished with various appendages in the different families of insects, such as cerci, caudal setæ, claspers, ovipositors, stings, and cornicles or honey tubes.

## INTERNAL ANATOMY.

The muscles are transparent and colorless, or of a yellowish white color, those moving the body segments being fastened to the body wall. These muscles are very strong, and are capable of rapid motion. Physicists have estimated that certain gnats move their wings at the rate of 15,000 times per second, the estimate being based upon the pitch of the musical note produced.

Insects breathe through a series of openings called spiracles, along the sides of the thorax and abdomen. Each segment bears two of these spiracles, one on either side, and the openings, though often simple, are sometimes provided with valves or fringes of hair to keep out the dust. Connecting with the spiracles are a series of air tubes or tracheæ which ramify through the body of the insect. Aquatic insects are provided with special devices for respiration, most immature forms having tracheal gills, but in a few dragon-flies and some stone-flies tracheal gills are retained throughout the insect's existence. A mosquito larva has a tube at the posterior extremity of the body which is protruded from the surface of the water for the purpose of obtaining air. Certain aquatic Hemiptera called backswimmers and water-boatmen carry down bubbles of air under their folded wings.

The blood is a thin, watery fluid, and does not flow through a system of closed tubes, as in the higher animals, but fills the entire body cavity not occupied by other organs. There is a single longitudinal blood vessel above the alimentary canal, pulsatile in its posterior part, and provided with valves which permit the blood to move only toward the anterior extremity of the vessel, where it is discharged into the body cavity.

The alimentary canal is a tube extending through the body. In adults this is much longer than the body, and is more or less folded, but in caterpillars it is only a straight tube reaching from one end of the body to the other. Fatty tissues make up a large portion of the contents of the body cavity.

The nervous system in insects is more highly developed than in other invertebrates. A large ganglion in the head is analogous to the brain of vertebrates, and is connected with a series of ganglia, one for each body segment, situated beneath the alimentary canal, on the floor of the body cavity.

All insects are developed from eggs, and in most cases oviposition takes place on or near the host or food plant. Some insects, however, retain the eggs within the oviducts until they are developed, and accordingly bring forth living young. These insects are said to be viviparous. In many of the plant lice, a number of generations are produced viviparously and without fertilization, after which another generation is produced in the normal fashion from fertilized eggs. The external reproductive organs are usually situated at the extremity of the abdomen.

## SENSES OF INSECTS.

Insects seem not to be very sensitive to pain; and some kinds will live for hours if head or abdomen be severed from the thorax.

Sight is well developed, and the eyes are best understood of all sense organs. Though larvæ have only ocelli or simple eyes, adults have also compound eyes, which are very large in dragon-flies and some other insects, enabling them to see in all directions at once.

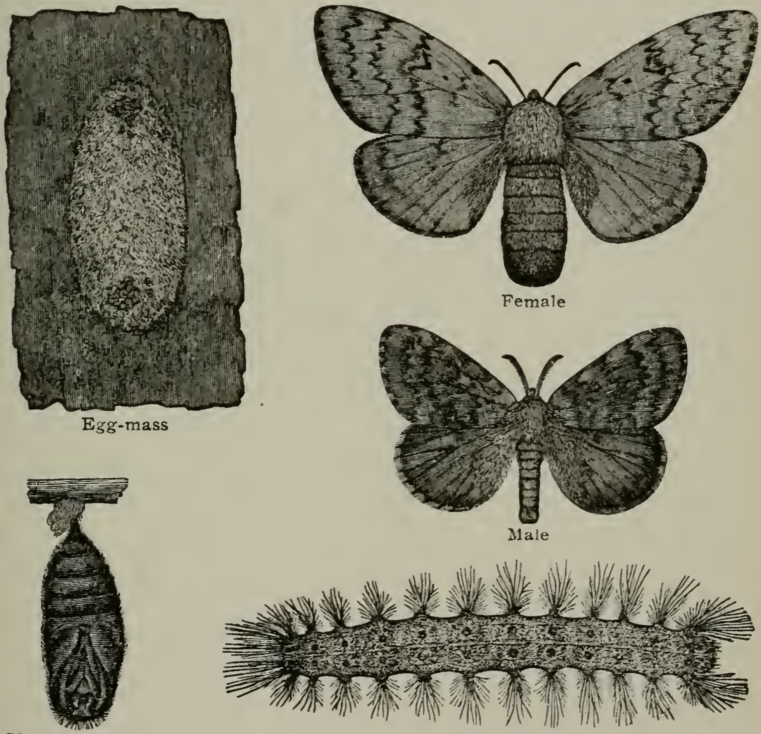
Hearing is a sense supposed to be possessed by insects from the fact that many species sing or stridulate. The ears of grasshoppers are on each side of the basal segment of the abdomen, and crickets have them on the tibiæ of the fore legs.

Taste is unquestionably a matter of fact in insect life, because the various species are able to discriminate between foods, though perhaps attracted to their food by the sense of smell, which is very highly developed. There is no organ corresponding to a nose, but the sense of smell is supposed to be situated in the antennæ, and males have it developed more highly than females; by it the former are able to find the latter, and both sexes find their food even by night.

## GROWTH AND METAMORPHOSES OF INSECTS.

The most primitive order of insects (Thysanura) have no transformations or metamorphoses, but the young, except in size, resemble the adults. Most kinds of insects, however, pass through four distinct stages in their life cycle; namely, egg, larva, pupa, imago. (See Fig. 2.)

We are all familiar with the egg of the potato beetle, which is laid on the under side of the leaf. Of many different forms are the eggs of the various kinds of insects, some being globular, some elongated, some smooth, others elaborately sculptured and very handsome. Most of them are of small size, some laid singly and others in large masses. The eggs of flies hatch in a few hours; but the eggs of the tent caterpillar (*Malacosoma americana* Harr.), shown in Fig. 3, and of the gypsy moth (*Porthetria dispar* Linn.), shown in Fig. 2, remain on the trees from July to the following May, or about nine months, before hatching. These cases well represent the extremes to be found


Egg-mass

Female

Male

Chrysalis or pupa

Caterpillar

FIG. 2. The four stages in the life cycle of an insect: Gypsy moth, *Porthetria dispar*. All figures natural size.

in Connecticut insects as regards the time required for the eggs to hatch. Many species pass the winter in the egg stage.

The larva is the stage during which the insect feeds and increases in size, casting its skin, or molting, from time to time. The larva of a moth or butterfly is commonly called a caterpillar, that of a fly is known as a maggot, and that of a beetle is often called a grub. It is in this stage that most of the damage is done by insects. Few insects require more than a year in this stage, most of them but a few weeks, and some only a few days or hours. A number of species winter as larvæ.

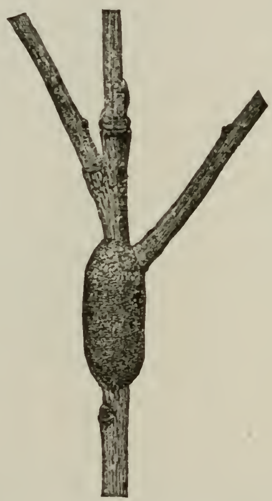


FIG. 3. Egg-mass of Tent Caterpillar on apple twig. Natural size.

The pupa, called chrysalis in the butterflies and moths, is the quiescent or non-active stage assumed by the larva when fully grown. The tissues inside break down almost completely to a homogeneous mass of protoplasm, and from this the various parts of the adult, beginning with the head and brain, are formed. The insect thus emerging is entirely different from both larva and pupa, a state of affairs not occurring so markedly in any animals outside of the insects. A large number of species pass the winter in this stage, but some of the flies require but a few hours or days in the pupa stage. Sometimes the pupa is naked, but often a cocoon of silk threads is made by the caterpillar before transforming. Many insects pupate in the ground.

The imago or adult is the mature insect, fitted for reproduction, after which it lives but a short time. This is the only stage in which we find fully developed wings. The adults of many insects take very little or no food except perhaps the nectar of flowers or the juices from mutilated plants or animals. Beetles, however, feed as well as their larvæ, and in some cases do quite as much damage, and the adults of some other orders also take food. Many insects pass the winter as adults, going into protected places such as buildings, or under stones, fences, or rubbish.

Insects having the four well marked stages just described are said to have complete transformations or metamorphoses. Among these are included the butterflies and moths (Lepidoptera), beetles (Coleoptera), flies (Diptera), bees and ants (Hymenoptera).

Most of the other insects, and especially the Orthoptera (grasshoppers, crickets, etc.), and the Hemiptera (plant lice, scale insects, and true bugs) do not pass through these four stages, but from the egg something hatches resembling the mature insect. These are said to have incomplete transformations or metamorphoses. Here we have three stages; namely, egg, nymph, imago. The nymph feeds and increases in size, molting from time to time, and having a somewhat different appearance after each molt, but gradually approaching the size and appearance of the imago or adult.

Many of these insects cause injury to plants in the adult as well as in the nymph stages, and the winter may be passed in each of the three stages. Thus almost all grasshoppers lay eggs in the fall, and these do not hatch until the following spring; but nymphs of certain species may be found on warm days late in autumn and early in spring; while some of the true bugs, like the squash bug (*Anasa tristis* DeG.), crawl into protected places and pass the winter season as adults.

## CLASSIFICATION OF INSECTS.

The following analytical key has been adapted from the key arranged by Prof. H. E. Summers and given in Kellogg's *American Insects.* It applies only to adult insects.

### *Key to Orders.*

1. Mouth-parts projecting, or not withdrawn into a cavity in the head. Normally with wings, which are sometimes rudimentary or wanting .................. 2

Mouth-parts withdrawn into a cavity in the head. Wingless insects, sometimes having abdominal legs, and feet having one or two claws...... **THYSANURA**

2. Mouth-parts fitted for biting; abdomen broadly joined to thorax; feet never bladder-shaped............. 3

Mouth-parts fitted for sucking, sometimes in part for biting. In latter case, either the base of abdomen is usually strongly constricted and joined to thorax by a narrow peduncle, or the tarsi are bladder-shaped without claws .............................. 14

3. Rear end of abdomen without prominent unjointed appendages resembling forceps .................... 4

Rear end of abdomen with prominent appendages resembling forceps; fore wings, when present, short, veinless, horny or leathery....... **EUPLEXOPTERA**

4. Fore wings not membranous..................... 5

Fore wings, if present, membranous like rear wings; latter occasionally, but not usually, folded like a fan 6

5. Fore wings, if present, leathery, usually with many veins, and thicker than the rear wings, which are folded lengthwise like a fan. If wings are absent, labium is cleft in middle and prothorax is large **ORTHOPTERA**

Fore wings, if present, veinless, horny or leathery; if absent, labium is entire............... **COLEOPTERA**

6. Antennæ inconspicuous ............................ 7

Antennæ conspicuous .............................. 8

7. Rear wings smaller than fore wings; posterior end of abdomen with two or three many-jointed filaments **EPHEMERIDA**

Rear wings as large as fore wings; posterior end of abdomen lacking many-jointed filaments....**ODONATA**

8. Tarsi with less than five joints; labium cleft in middle 9
Tarsi with five joints; labium entire.................. 12

9. Rear wings not broader than fore wings, sometimes absent, not folded in repose; prothorax small, collar-like .......................................... 10
Rear wings broader than fore wings; both pairs present, folded in repose; prothorax large, nearly flat on dorsal surface .........................**PLECOPTERA**

10. Tarsi with less than four joints..................... 11
Tarsi with four joints; wings, when present, equal in size .................................**ISOPTERA**

11. Tarsi with one or two joints; always wingless........ **MALLOPHAGA**
Tarsi usually three-jointed, occasionally two-jointed, in which case wings are present; fore wings larger than rear wings .......................**CORRODENTIA**

12. Wings naked or slightly hairy...................... 13
Wings thickly covered with hairs.......**TRICHOPTERA**

13. Mouth-parts not prolonged into a distinct beak, at most slightly conical ...................**NEUROPTERA**
Mouth-parts prolonged into a distinct beak **MECOPTERA**

14. Prothorax free, body and wings not densely clothed with scales ..................................... 15
Prothorax not free; maxillary palpi present, sometimes rudimentary and obscure, in which case body and wings are densely clothed with scales; tarsi usually with claws, and never bladder-shaped.............. 16

15. Tarsi bladder-shaped, without claws; wings four (sometimes absent), narrow, fringed with long hairs...... **THYSANOPTERA**
Tarsi not bladder-shaped, usually with claws; wings not fringed with long hairs; maxillæ bristle-like, without palpi .............................. **HEMIPTERA**

16. Mandibles often rudimentary, and bristle-like when present ........................................ 17
Mandibles well developed, fitted for biting; wings four (sometimes two or none), naked or with scattered hairs ..........................**HYMENOPTERA**

17. Wings two (or wanting). Rear wings represented by halteres; wings and body naked or covered with scattered hairs; mouth a soft or horny beak not coiled under head.............................. 18
    Wings four (sometimes wanting in females). Wings and body covered thickly with scales or hairs; mouth, when developed, a slender sucking proboscis coiled under the head.....................**LEPIDOPTERA**
18. Prothorax poorly developed, scarcely visible from dorsal side. Usually two wings............**DIPTERA**
    Prothorax well developed, distinctly visible from dorsal side; wings never present..........**SIPHONAPTERA**

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The following arrangement of the orders is in the main that of Comstock, modified in the Neuropteroid groups by Banks, and runs from the lowest to the highest forms. This sequence could not be carried out exactly in the key, but should be followed in the arrangement of insect collections. The principal orders are illustrated by typical examples in Plates III-V.

**THYSANURA.** Spring-tails, bristle-tails, and fish moths. A small order, and the insects are mostly of small size, inhabiting moist, decaying vegetable matter.

**ODONATA.** Dragon-flies and damsel-flies. Plate III. A small or medium-sized order, containing some species of large size. All are aquatic in their larval stages, and feed in both larval and adult stages upon other insects, especially mosquitoes.

**EUPLEXOPTERA.** Earwigs. Plate VII. This order contains only the earwigs, and there are but few species. Many writers treat it as part of the *Orthoptera,* though it differs structurally.

**ORTHOPTERA.** Grasshoppers, crickets, walking-sticks, mantids, and cockroaches. Plates III, VI-XI. This order does not contain a great number of species, but some of them are of large size and therefore noticeable. Nearly all (except the mantids and the crickets) feed upon vegetable food, and some species are very injurious.

**THYSANOPTERA** (or **PHYSOPODA**). Includes only the family *Thripidæ.* A small order of small-sized individuals, mostly inhabiting flowers. A few species are injurious.

**HEMIPTERA.** Lice, aphids, bugs, scale-insects, leaf-hoppers, tree-hoppers, psyllids, cicadas, and other sucking insects. Plate III. This large and important order contains many species and individuals. It is divided by some authors into three orders, namely, the **HOMOPTERA**, including cicadas, leaf-hoppers, aphids, and scale-insects; the **HETEROPTERA**, including the assassin-bugs, leaf bugs, bed-bugs, and related forms; the **PARASITICA**, including the lice which are parasitic upon man and the higher animals. There are a great many species among the Hemiptera which are regarded as injurious.

**ISOPTERA.** Termites or white ants. A small order, including a single family of social insects. Some species are very destructive, tunneling in trees, construction timbers, etc.

**MALLOPHAGA.** Biting bird-lice. A small order of small wingless parasitic insects, having incomplete metamorphoses. The species infest fowls and wild birds.

**CORRODENTIA.** Book-lice. A small order of small-sized insects which feed upon paper, lichens, etc.; not of much economic importance.

**PLECOPTERA.** Stone-flies. A small order, including a single family, of little economic importance. Larvæ aquatic, serving as food for fishes.

**EPHEMERIDA.** May-flies or Day-flies. This order contains only a single family of insects, of which there are few species, but many individuals, found near lakes and rivers. Not important economically.

**NEUROPTERA.** Dobsons, ant-lions, lace-wings, etc. Plate III. A rather small group of insects with transparent membranous wings. Some species, like the dobson, are of large size.

**MECOPTERA.** Scorpion-flies. A small but remarkable group of insects, with the head prolonged into a beak. So far as known, these insects are carnivorous.

**TRICHOPTERA.** Caddis-flies. A small but interesting order of moth-like insects. The adults have parchment-like wings, which are more or less hairy and folded against the sides of the abdomen. The larvæ are aquatic, and make peculiar cases in which they live in the water.

**LEPIDOPTERA.** Moths and butterflies. Plate IV. A large and important order, including some of the largest and most beautiful of all insects. The wings are covered with scales. Many species are pests of vegetation, but many others are useful in carrying pollen from flower to flower.

**DIPTERA.** Flies and mosquitoes. Plate V. The insects of this large order have but two wings, which are usually transparent. There are many species, and some of them are very abundant. This order furnishes a number of important pests, and is probably more dangerous to man, on account of some of its members transmitting disease germs, than any other order of insects.

**SIPHONAPTERA.** Fleas. A small order of small-sized wingless insects, usually considered as an off-shoot from the *Diptera,* though sometimes included as a part of that order. Fleas annoy man and the domestic animals, and recently have been found to be important agents in transmitting the germs of bubonic plague.

**COLEOPTERA.** Beetles. Plate V. One of the largest and most important orders of insects, easily recognized on account of the horny wing covers. Some species are found in almost every kind of habitat. Many are distinctly injurious, though the predaceous forms, like ground beetles, are regarded as beneficial. In size, beetles vary from microscopic to nearly three inches in length. About 12,000 species are known in North America.

**HYMENOPTERA.** Bees, wasps, ants, saw-flies, horntails, and ichneumon flies. Plate V. A large and important order, commonly regarded as the most highly developed of all insects. Some groups, like the bees, ants, and certain wasps, are social in their habits. Most of the *Hymenoptera* are beneficial. The honey bee gives us honey and wax, and the ichneumon flies parasitize many injurious species. The honey bees and their near relatives play an important part in the pollination of plants, and the orchardist owes his fruit crop to the agency of this group of insects.

## PART II

# Euplexoptera (Earwigs) and Orthoptera (Grasshoppers, Crickets, etc.), of Connecticut

BY

BENJAMIN HOVEY WALDEN

# The Euplexoptera and Orthoptera of Connecticut

## INTRODUCTION.

The insects discussed in this paper belong to two orders, the *Euplexoptera* and the *Orthoptera,* following the classification adopted for the collection of the Connecticut Agricultural Experiment Station. This collection contains Connecticut representatives of eighty-two species, from which many of the records in this paper are taken. Some writers recognize but one order, and include the small group *Euplexoptera* under *Orthoptera.*

In 1872, Professor Sidney I. Smith of Yale University, who was at that time entomologist of the State Board of Agriculture, presented to the Board a report on the Orthoptera of Connecticut. This paper mentions sixty-one species, of which a few are varieties or synonyms. Probably the most careful collecting in Connecticut in the *Acrididæ,* one family of this order, has been done by Professor Albert P. Morse of Wellesley, Massachusetts, a leading authority on the group. In his "Notes on the Acrididæ of New England" he records all of the species of this family taken by him. In the "Catalogue of the Orthoptera of New England," by Professor Samuel H. Scudder, are recorded seventy-four species as probably occurring in Connecticut. These records were probably largely furnished by Professors Morse and Smith.

The present paper includes one hundred and nine species, one hundred of which have been recorded from the state. The remaining nine species and probably a few others will undoubtedly be found by careful collecting. The arrangement of the genera and species is in general based upon the "Catalogue of the Orthoptera of the United States and Canada," by Scudder.

In the preparation of the keys and descriptions free use has been made of various works on the Orthoptera, especially the "Acrididæ of New England," by Professor Morse, and the "Orthoptera of Indiana," by Professor W. S. Blatchley.

## ACKNOWLEDGMENTS.

The writer is greatly indebted to Dr. Britton for much help and many suggestions throughout the preparation of this paper.

Professor A. P. Morse has examined the material in the Station collection, the records in this paper being based largely upon his determinations. Professor Morse's kindness in examining material, loaning specimens for study, and answering questions pertaining to the group, has been greatly appreciated.

Thanks are due to Professor A. E. Verrill of Yale University, through whose kindness we were able to examine the *Orthoptera* stored in the attic of Peabody Museum; to Professor W. S. Blatchley and to Mr. Wm. Beutenmüller for records of *Orthoptera* taken by them in Connecticut.

The measurements are given in millimeters, and refer to the length unless otherwise stated; thus the word "body" with "19-25" under it means that the body from the front of the head to the tip of the abdomen is from 19 to 25 millimeters in length. The measurements of the *Acrididæ* are from Morse's papers, as his figures under many of the species are based upon the careful measurements of several hundred specimens.

The keys apply to Connecticut species only, and are for distinguishing the adults and not the nymphs.

All figures of insects in Plates VI-XI are natural size. Figure 2, of Plate VI, is from the Report of the Connecticut Agricultural Experiment Station for 1903. Figure 3 is from a photograph kindly loaned by Professor M. V. Slingerland of Cornell University. Figures 1 and 4, of the same plate, and the remainder of the plates are from photographs by the author.

Figures 5-15, 17-26, 28-35, 37-48, in the text, are redrawn from Morse. Figures 49-52 are redrawn from Scudder. Figure 61 is from a drawing by W. E. Britton. All others are from drawings by the author.

## EXPLANATION OF COLLECTORS' INITIALS.

W. B. — William Beutenmüller, New York. Curator of Entomology, American Museum of Natural History. Has collected *Orthoptera* in Connecticut.

W. E. B. — W. E. Britton, New Haven, State Entomologist and Entomologist of the Connecticut Agricultural Experiment Station. The author of a number of papers on Connecticut insects. Has collected in nearly all parts of the state.

W. S. B. — W. S. Blatchley, Indianapolis, Ind. A leading specialist in the *Orthoptera*. Has collected in Connecticut.

A. P. M. — Albert P. Morse, Wellesley, Mass. Curator of Museum at Wellesley College, and Research Assistant, Carnegie Institute of Washington. A well-known specialist, who has collected *Acrididæ* in the principal sections of the state. The records of his captures are given in "Notes on the Acrididæ of New England," published in *Psyche*.

E. J. S. M. — E. J. S. Moore, New Haven, a student employed temporarily as assistant in the entomological department of the Connecticut Agricultural Experiment Station. Collected chiefly around New Haven.

S. I. S. — Sydney I. Smith, New Haven, Professor of Comparative Anatomy, Yale University. An early student of the *Orthoptera*.

A. E. V. — Addison E. Verrill, New Haven, Professor of Zoölogy, Yale University. Has collected insects in various parts of the state, but chiefly around New Haven and on the Thimble Islands.

H. L. V. — Henry L. Viereck, Philadelphia, for more than a year Assistant in Entomology at the Connecticut Agricultural Experiment Station. Has collected in nearly all sections of the state, but more especially around New Haven and along the shore.

B. H. W. — B. H. Walden, New Haven, Assistant in Entomology at the Connecticut Agricultural Experiment Station. Has collected in nearly all parts of the state.

## EUPLEXOPTERA.

The members of this order, commonly called "earwigs," are recognized by their slender, flattened bodies, legs of nearly equal size, and abdomen terminating with a pair of forceps-like appendages.

Head prominent, flattened, and wider than the thorax, with mouth-parts in front. Thorax small. Tegmina or wing covers meeting in a straight line down the back and covering only part of the abdomen; leathery in texture and without veins. Wings large in proportion to the size of the insect; folded lengthwise like a fan and then again crosswise, and thus concealed under the comparatively small wing covers. It is stated that the insects use the above-mentioned forceps in tucking the wings under the covers. The tegmina and wings are both absent in one of our species. The metamorphosis is incomplete.

These insects are much more plentiful in Europe, where they received the name "earwig" from a foolish superstition that they sometimes get into people's ears and injure them. Earwigs are not common in Connecticut, and are seldom seen, as they live in cracks and crannies, beneath stones, bark of stumps, etc., coming out only at night. They are largely vegetable feeders, but eat dead insects and small sluggish forms of animal life. The order includes only a single family.

### FORFICULIDÆ.

The members of this family will be recognized by the above description. Two species belonging to different genera have been taken in Connecticut. Other members of this family will probably be found when carefully looked for. A third genus, which should be represented in this state, is added to the following key.

*Key to Genera.*

1. Tegmina and wings present........................ 2
   Tegmina and wings both absent..........**Anisolabis** p. 45
2. Joints of antennæ cylindrical, more than four times as long as broad. Second tarsal joint broadened at apex, bilobed, and produced beneath the third
   **Forficula** p. 45

Joints of the antennæ cone-shaped, wider at apex than at base. Second tarsal joint very small, simple, and compressed .............................. **Labia** p. 46

### **Anisolabis** Fieber.

Body long and slender, sides nearly parallel throughout. Tegmina and wings absent. Antennæ about one-half the length of the body. First and third tarsal joints sub-equal, second joint smaller. Forceps stout and slightly curved.

**A. maritima** Bonnel. Plate VII, 1.

Dark mahogany brown above, lighter below; legs yellowish brown.

Measurements.

| Length | Width | Forceps |
|---|---|---|
| 15-22 | 3-4 | 3-4 |

Occurs along the coast from Maine to Florida. Outer Island, Branford (A. E. V.); Bridgeport (F. Knab); Milford, 30 May (B. H. W.).

### **Forficula** Linnæus.

Body somewhat flattened, generally long and slender, sides of abdomen parallel, antennæ a trifle longer than half the length of body, with ten to fifteen cylindrical and nearly equal joints, which are more than four times as long as broad. Wing covers present, wings sometimes present. First joint of tarsi longer than the third; second short, broadened at apex, and extending beneath the third joint.

*Key to Species.*

1. Wings reaching beyond the tips of the tegmina....... 2
   Wings wanting or much shorter than the tegmina **aculeata**
2. Middle legs much nearer the fore than the hind legs. Forceps of male with an inner tooth at the arcuate portion ................................. **auricularia**
   Middle legs but little nearer the fore than the hind legs. Forceps of male with basal tooth on inner edge. .**pulchella**

**F. aculeata** Scudder.

"Dark chestnut brown; palpi and legs luteous; thorax longer than broad and narrower than the head, the sides pale luteous;

wing covers nearly twice as long as the thorax, luteous, and broadly margined inwardly with deep chestnut brown; hind wings considerably shorter than the wing covers; male forceps about three-fourths as long as the abdomen, slender, arcuate, bent downward beyond the middle and again horizontal to the tip, before which is also a short tooth; pygidium with a long sharp point. Length of body, male and female, 9-11 mm.; forceps of male, 4-5 mm.; female, 2.5-3.5 mm."*

Northern United States east of Mississippi River. Has not been taken in Connecticut.

**F. auricularia** Linnæus.

"Fusco-ferruginous; antennæ 14-15 jointed; basal joint, sides of thorax and legs testaceous; wings and wing covers dull luteous, the latter half as long again as the pronotum; forceps of male usually as long as the abdomen, horizontal, depressed, and dilated at the base, and beyond rather strongly arcuate, tapering to a point, the extreme base of inner edge tuberculate-denticulate, with a distinct inner tooth at base of the arcuate portion. Body about 11 mm.; forceps, male, 4-8 mm.; female, 3 mm."*

New York, New Jersey. Probably occurs in Connecticut.

**F. pulchella** Serville.

"Head blackish; antennæ brown, paler at base; thorax brown, with the sides and hind margin paler; wing covers brown; wings yellow edged with brown; abdomen reddish brown; forceps of male arcuate in the middle, pointed, with an inner tooth near the base. Length of body, 8 mm.; forceps of male, 5 mm.; female, 2.5 mm." *

Has been taken in New York.

### **Labia** Leach.

"Size, small. Body flattened and slightly widened at the middle. Antennæ about one-half the length of the body, with ten to twelve joints which are about three times as long as broad. Tegmina present. Wings sometimes absent, but present in our species. First and third tarsal joints equal in length, second joint small, simple and compressed. Forceps about half the length of the abdomen, separated at the base in the male, not separated in the female." *

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* Descriptive Catalogue of the Orthoptera found within fifty miles of New York City. Beutenmüller.

**L. minor** Linnæus. Little Earwig.

"Much smaller than any of the preceding species. Light brown, pubescent; head blackish; antennæ 10-12-jointed, fuscous; mouth-parts pale; pronotum narrower than the head, and a little longer than broad; wing covers nearly twice as long as the thorax; hind wings as long as the pronotum; legs pale luteous; abdomen reddish brown in the middle above; forceps of male more than half as long as the abdomen, and distinctly serrulate on inner edge; last segment of male with an apical, compressed, upcurved, long and slender tubercle. Length of body, 3.75-6 mm.; forceps, 1.25-2 mm."*

Meriden, 3 June (W. E. B.); Lyme, 23 August (A. B. Champlain); Berlin, 28 September (D. J. Caffrey).

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* Descriptive Catalogue of the Orthoptera found within fifty miles of New York City. Beutenmüller.

## ORTHOPTERA.

The insects in the order *Orthoptera* with which we are all familiar are the grasshoppers or locusts, katydids, crickets, and cockroaches. The order also contains the walking-sticks, which are rarely seen, and the mantids, two species of which have but recently been introduced into Connecticut.

The *Orthoptera* belong to the group of insects having an incomplete metamorphosis and biting mouth-parts. The wings, when present, are four in number. The outer pair, or tegmina, as they are called, are not used for flight, but are thick and leathery in texture and serve as covers for the under wings. When closed, their inner edges usually overlap. The second pair of wings are the ones with which the insects fly, and are thin, delicate, and folded lengthwise like a fan. The name *Orthoptera* is from the Greek words *orthos*, straight, and *pteron*, a wing, referring to the longitudinal straight folds of the hind wings. The wings of some species of *Orthoptera* are absent while other species have only the tegmina present.

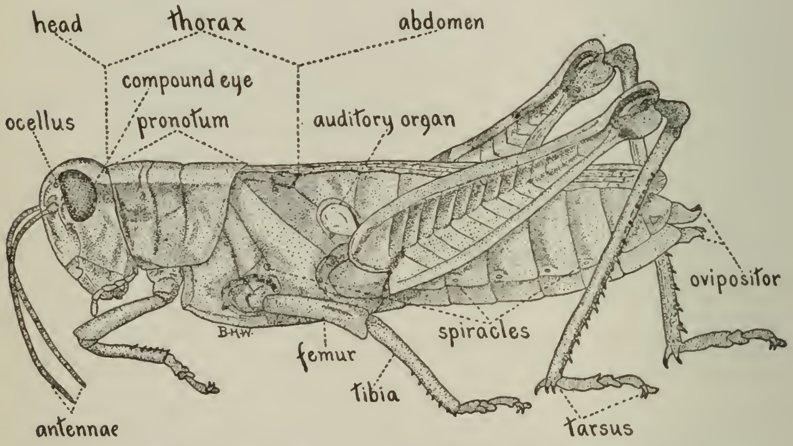

FIG. 4. *Melanoplus bivittatus.* Diagram showing principal parts of a locust.

### ECONOMIC IMPORTANCE OF THE ORDER.

The *Orthoptera* are of great economic importance, as all of them, with the exception of the *Mantidæ*, are injurious, and nearly all feed upon vegetation. From the earliest Bible times the locusts (*Acrididæ*) have been recorded as doing great damage to agricultural crops. Certain migratory species would pass in great numbers over a portion of the country destroying all the cultivated crops and even defoliating the shrubbery and trees. It is within the memory of many when the Rocky Mountain locust caused millions of dollars' worth of damage in the west. Even New England, in her early days, did not escape the ravages of an allied species, *Melanoplus atlanis*.* Smith in his report to the Board of Agriculture states, "In 1743 and 1756 they threatened to destroy the whole vegetation in some parts of the country, and so great was the alarm they occasioned among the people, that days of fasting and prayer were appointed on account of the threatened calamity." While no such invasion is likely to occur in these days, much damage is done each year by these insects. This will be impressed upon any one who walks through the meadows and fields at any time from July until frost, and notes the members of this order that are hopping around on every side; and the possible damage that may be done will be appreciated when one remembers that each of these little insects is "born with one earthly desire — a voracious appetite — and with one valuable possession — a pair of strong, broad jaws, which move in and out like the blades of a pair of scissors; the little hopper soon begins to use the latter to appease the former, and for twenty-four hours a day and seven days a week, he gnaws away at the soft, green, succulent grass which surrounds him on every side."

Numerous as the *Orthoptera* are, very little attention is paid to them by the farmers of the state. It would be difficult to estimate the damage to mowing-lands and pastures from these insects; and, while the yield must be considerably reduced each year, their work probably escapes unnoticed excepting in very dry seasons, when the conditions are the most unfavorable for the growth of the grass and most favorable for the development of the *Orthoptera*.

In 1872, Professor Sidney I. Smith recommended a flock of poultry, especially turkeys, as one of the best means of destroying grasshoppers. Probably there is nothing better to suggest at this time for reducing their numbers, and, judging from market prices, the turkeys could be disposed of at a fair profit.

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* This species is mentioned by Smith as being *M. femur-rubrum*, but it was probably *atlanis*, as the migratory habit is peculiar to the latter species.

The eggs of the *Acrididæ* are readily killed by plowing the land in which they are deposited in the fall. Possibly the most apparent damage by the *Orthoptera* is in the tobacco fields. The writer has seen strips around the edges of fields where the leaves were badly eaten. This is more liable to occur where the fields are bordered by wild vegetation than where the tobacco adjoins cultivated fields or where the edges are kept clean. Species of *Scudderia,* the Carolina locust (*Dissosteira carolina*), and the red-legged locust (*Melanoplus femur-rubrum*), have been observed in the center of fields; but species of *Xiphidium* and the majority of the individuals of the above-named species work principally on the edges of the fields. Clean cultivation, or poisoning the native growth and the tobacco around the edge of the field, will prevent much of this damage.

The cranberry crop is often damaged considerably by katydids. Professor J. B. Smith of New Jersey has studied these insects on the bogs, and finds that two species, *Scudderia texensis* and *S. curvicauda,* cause much of the damage. These insects eat into the berries to get the seeds, after which the berries dry up.

Clean culture on the bogs and around the margins, keeping the bogs flooded as much as possible, especially late in spring, and burning the bogs to destroy the leaves in which the *Scudderia* eggs are laid, are the methods of treatment recommended.

## NATURAL ENEMIES.

The *Orthoptera* have many natural enemies which greatly reduce their numbers, and prevent them from over-running our farms and destroying everything that grows.

One of the important parasites is a fungus, *Empusa grylli* Fres. This is especially common in a wet season. Locusts attacked by this fungus climb the stems of grasses and weeds, where their dead bodies are seen late in the season. This peculiar habit is an important aid in the distribution of the disease, as from this elevated position the spores of the fungus may be blown over a considerable area. The *Orthoptera* are also attacked by bacterial diseases, especially during long warm damp periods.

A great many locusts are attacked and killed by a red mite, *Trombidium locustarum* Riley. This is often seen clinging to the body of the locust, where it sucks out the vital juices. These mites are often very numerous, one female sometimes producing three hundred or more eggs. The winter is passed in the ground, where they are active except during freezing weather. They feed upon a variety of soft substances, and are especially fond of locust eggs.

Another animal parasite that attacks various species of *Orthoptera* is a "hair worm," a species of *Gordius*.

The group also has a large number of insect enemies, among which are tachina flies, flesh flies, larvæ of blister beetles, and carabid beetles. Toads, moles, shrews, and snakes feed upon one or all stages of *Orthoptera*.

Many species of birds include the insects of this order in their diet. The average person has very little idea of the variety of birds that feed upon insects, or the number of insects that some of these birds eat. Many of the insect-eating birds feed largely upon *Orthoptera*.

## ORTHOPTERA.

### *Key to Sub-orders.*

Legs nearly equal in size. Hind femora not enlarged for leaping. Sound-producing organs absent. Ovipositor concealed ................. **NON-SALTATORIA** p. 52

Legs unequal in size. Hind femora enlarged and thickened for leaping, generally much longer than the middle femora. Sound-producing organs usually present. Ovipositor usually plainly visible.... **SALTATORIA** p. 62

## NON-SALTATORIA.

The insects of this sub-order have the legs fitted for running rather than for leaping. There are three families (not including *Forficulidæ*) in this group in the United States, all of which are represented in Connecticut,* and may be distinguished by the following key:

### *Key to Families.*

1. Body short, broad, oval, and strongly flattened. Head nearly concealed by pronotum. Ocelli two. Pronotum shield-shaped, transverse. Legs compressed BLATTIDÆ p. 52

Body elongate, narrow. Head free, not covered by pronotum which is much longer than broad. Ocelli three or wanting. Legs slender, not compressed.... 2

2. Head oblique, mouth inferior. Ocelli three. Pronotum generally longer than any other segment. Front pair of legs fitted for grasping. Cerci jointed......... MANTIDÆ p. 59

Head sub-horizontal, mouth-parts nearly inferior. Ocelli often wanting. Pronotum very short. Front pair of legs not fitted for grasping. Cerci not jointed ........................ PHASMIDÆ p. 61

## BLATTIDÆ.

This family includes the insects known as cockroaches. The body is oval and much flattened, head nearly horizontal, almost covered by the broad pronotum, and bent under so that the mouth-parts project back between the front pair of legs. The antennæ are long and slender. The pronotum is usually broader than long, or shield-shape. The rings of the abdomen overlap each other and are capable of being much depressed, so that these insects can readily adapt themselves to the cracks and narrow places in which they live. The legs are long, enabling the cockroach to run very swiftly. The wing covers contain many veins and are parchment-like or leathery, overlapping when at rest. The wings are never longer than the tegmina and are rudimentary or even wanting in some species.

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* The family *Mantidæ* is represented in Connecticut only by introduced species.

Everyone is more or less familiar with the cockroach or water-bug. Our troublesome species are introduced and infest dwellings, delighting to live in the cracks and crevices in warm damp places, such as are found around steam and water pipes, back of sinks, etc. These insects are nocturnal in habit, coming out at night and feeding upon a great variety of substances, including all kinds of provisions, clothes that are starched, and book bindings. In Connecticut we have taken three species that commonly inhabit houses. Besides these there are probably several native species that live under the loose bark of trees and rubbish. Of these, however, only two species have been taken.

Some of the tropical species are occasionally brought into the state with fruit, especially bananas. Specimens of a large brown species, probably *Nyctobora mexicana* Sauss., have been seen by the writer, and a specimen of a large, handsome green species, *Panchlora poeyi Sauss.*, has been taken by Dr. Britton on bananas in New Haven. *Leucophaea surinamensis* Linn. has been very abundant for several years in greenhouses at Cromwell.

### *Key to Sub-families.*

Last ventral segment of the female plane, without a ridge, and undivided. Fore femora rarely armed beneath on the inner margin with many distinct spines; when so armed, the subgenital styles unequal or one wanting BLATTELLINÆ p. 54

Last ventral segment of the female abdomen compressed so that a ridge or carina is formed on its under side, and divided so as to be bivalved. Fore femora armed beneath on the inner margin with many spines; styles of equal length.................... PERIPLANETINÆ p. 57

### BLATTELLINÆ.

*Key to Genera.*

Size large. Sub-genital stylets present in the males. Tegmina of females abbreviated, not reaching more than two-thirds the length of the broad abdomen **Ischnoptera** p. 54

Size small. Sub-genital stylets absent in the males. Tegmina of both sexes fully developed.............. **Blattella** p. 56

### **Ischnoptera** Burmeister.

Body of male narrow and elongate, sides sub-parallel, female with body wider and more rounded. Antennæ much longer than the body. Pronotum rounded, usually narrowed in front. Tegmina longer than the abdomen in the males, much shorter (in our species) in the females. Wings present. "Cerci long, stout, 12-jointed, supra-anal plate of the male broad, apex either truncated or rounded, that of the female narrower, triangular, and obtuse. Sub-genital plate of the male bearing two rather long stylets which are often deflexed. Last abdominal plate of the female entire." This genus contains our two native species.

*Key to Species.**

Size large, total length 25 or more mm. Margin of pronotum much lighter than disk ...............**pennsylvanica**

Size smaller, total length less than 20 mm. Pronotum more uniform in color..............................**uhleriana**

I. **pennsylvanica** De Geer. Pennsylvania Cockroach. Plate VII, 2.

Male: pronotum elliptical, slightly narrowed in front with the margin straight. Posterior margin rounded. The disk with an oblique posterior depression on either side. Tegmina long and narrow extending much beyond the tip of the abdomen, membranous and more or less transparent. Wings as long as the tegmina. Female with the abdomen wider than the pronotum, the width more than one-half its length. Pronotum wide with the front margin narrowed and rounded, the posterior margin narrowed truncate. Disk with no oblique depressions. Tegmina broad, their inner margins overlapping, covering from one-half to two-thirds the abdomen, the tips rounded, and the veins prominent. Inner wings narrow, about half the length of the abdomen. Color chestnut-brown to fuscous, females the darker. Face reddish brown. Disk of pronotum with the lateral edges and sometimes the front yellowish white. Tegmina of male smoky brown, the outer basal two-thirds broadly margined with yellow. Those of female dark reddish brown with the outer basal half margined with yellow. Dorsal surface of female abdomen dark brown.

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* See note page 162.

Measurements.

| | Body | Antennæ | Pronotum | | Tegmina |
|---|---|---|---|---|---|
| | | | Length | Width | |
| Female | 16 | 18 | 5 | 7. | 6-10 |
| Male | 21 | 28 | 5 | 5.5 | 22 |

This species, found under the bark of stumps, or under stones and rubbish, is not usually common, but is sometimes attracted to country houses by light, where it may become a nuisance. Mt. Carmel, 18 June (E. F. Coe); 10 July (W. E. B.).

**I. uhleriana** Saussure.

Male: small; body narrow. Antennæ slightly longer than the body. Pronotum small, elliptical; hind margin rounded; sides somewhat deflexed, the oblique depressions distinct. Tegmina longer than abdomen, rather wide. Wings reaching tips of tegmina; supra-anal plate triangular. Female: body wider than that of the male. Pronotum rounded with the hind margin nearly straight. Tegmina covering less than half the abdomen, the inner margins meeting or slightly overlapping, the tips rounded, usually slightly emarginate near the inner angle. Disk somewhat convex. Depressions faint. Wings narrow and reaching only to second abdominal segment. Supra-anal plate triangular. Color of male light reddish brown; head and posterior margin of pronotum often darker. Female darker; general color dark reddish brown; tegmina sometimes chestnut brown. Dorsal surface of abdomen brown to piceous; legs pale reddish brown.

Measurements.

| | Body | Pronotum | | Tegmina |
|---|---|---|---|---|
| | | Length | Width | |
| Female | 11 | 3.3 | 3.7 | 3.7 |
| Male | 12 | 3 | 4 | 16 |

Occurs in the same places as *pennsylvanica*. Stonington, 25 June — 5 July (J. A. Hyslop); New Haven, 19 April (B. H. W.); 10 July (W. E. B.); Wallingford, 19 June (D. J. Caffrey).

### **Blattella** Caudell.

Our single species of *Blattella* is much smaller than the insects of the preceding genus. Body long and narrow; pronotum small and roundish, almost completely covering the head. Eyes large. Antennæ much longer than the body and thinly covered with long hairs. Tegmina membranous or a little leathery and as long or longer than the abdomen in both sexes. Sub-anal plate of male with the styles rudimentary or wanting. Last abdominal segment of female not notched.

**B. germanica** Linn. Croton-bug. Water-bug. German Cockroach. Plate VII, 3.

Color yellowish brown; the females, as in most species, often darker than the males. Legs lighter in color. Pronotum marked longitudinally with two dark brown bands separated by a stripe of yellow. Antennæ dark brown, exceeding slightly the tips of the tegmina, which reach to the end of abdomen (male) or somewhat pass it (female). The body of the female is shorter and broader than that of the male.

Measurements.

| | Body | Antennæ | Pronotum | | Tegmina |
|---|---|---|---|---|---|
| | | | Length | Width | |
| Female | 10 | 13 | 8. | 4. | 11 |
| Male | 13 | 14 | 2.5 | 3.25 | 9-10 |

This is an introduced species and is commonly known as the croton-bug from the fact that the species became numerous in New York at the time of the completion of the Croton aqueduct. The insects made their way along the pipes, entering houses connected with this system. It is probably the most abundant cockroach in Connecticut. While it is not so often met with in the country, it is quite common in cities, and, as it is not partial to filth, it is liable to infest any dwelling, especially one heated with steam, and may become the plague of the most careful housekeeper. It is usually confined to the kitchen and pantry where food is found in abundance. The most effective remedy against this insect is to fumigate the infested rooms with hydrocyanic acid gas. This gas is fatal to all animal life, so that its use is only practicable where the kitchen is isolated from the other part of the house, or where it can be shut up tightly. Carbon disulphide has been recommended, but this is quite inflammable and has a disagreeable odor. Borax and pyrethrum (insect powder) are often used as repellents. Burning the pyrethrum powder will kill and stupefy many of the insects.

### PERIPLANETINÆ.

This sub-family contains our largest cockroaches. These are introduced species; and one of them, the most disgusting of all our roaches, is well known. The chief distinguishing characters are given in the key. The head is large, flattened, and not entirely covered by the pronotum. The antennæ are more or less pubescent, the joints obconic and very short. The tegmina and wings are variable in the different species. In our species the hind tarsi have the first joint as long as, or longer than, the other two joints together.

### *Key to Genera.*

Tegmina of the male covering about three-fourths of the abdomen, those of the female much shorter. Distance between the eyes greater than length of last joint of maxillary palpus ........................... **Blatta** p. 57

Tegmina of both sexes extending beyond tip of abdomen. Distance between the eyes less than length of last joint of maxillary palpus.................... **Periplaneta** p. 58

### **Blatta** Linnæus.

This genus is recognized by the more widely separated eyes which are farther apart than the distance between the antennal pits or scrobes. The tegmina are short in both sexes, especially so in the female, and their outer edges less rounded than in *Periplaneta.*

**B. orientalis** Linnæus. Oriental Cockroach. Black Beetle. Plate VII, 4.

Dark mahogany brown, legs lighter. Pronotum without light margins or markings. The wing covers of female not over

5 mm. in length and the wings not developed. The tegmina and wings of male well developed, about equal in length, covering about three-fourths of the abdomen. Supra-anal plate of male truncated, that of the female rounded and with a shallow notch.

Measurements.

| | Body | Pronotum | | Tegmina |
|---|---|---|---|---|
| | | Length | Width | |
| Female | 26 | .. | 8.5 | 5 |
| Male | 22.5 | 6 | 7.5 | 12 |

The Oriental cockroach is probably found in all the larger towns of the State. Unlike the croton-bug, it seeks dark, damp, filthy places.

### **Periplaneta** Burmeister.

This genus contains our largest cockroaches. The inner wings are as long as the tegmina which extend beyond the tip of the abdomen in both species.

*Key to Species.*

Tegmina extending much beyond end of abdomen (10-12 mm.). Without light stripe on the outer margin of basal half....................................**americana**

Tegmina extending but little beyond end of abdomen (3-5 mm.). A yellow stripe on the outer margin of basal half **australasiæ**

**P. americana** Linnæus. American Cockroach. Plate VII, 5. General color, reddish brown, the pronotum with a submargin of yellow, which is broad at the rear and sides and narrowed in front; this incloses a brown area more or less bisected by a broken median stripe of yellow. Wings and tegmina long and well developed in both sexes. Notch of supra-anal plate of female deep.

Measurements.

| | Body | Pronotum | | Tegmina |
|---|---|---|---|---|
| | | Length | Width | |
| Female | 30 | .. | .. | .. |
| Male | 27 | 10 | 8 | 30 |

This large cockroach has been taken in New Haven but is probably much less common throughout the state than *orientalis.*

It is a native of tropical America, but has been distributed around the world. It is said to be much more cleanly in its choice of an abiding place than is *Blatta orientalis*. When numerous it becomes a serious pest.

"The young of the American roach require about a year to reach maturity. The rate of growth of it and other species depends, however, largely on the food and temperature conditions, and under unfavorable circumstances the nymph stage is much prolonged." "The abundance of roaches is, therefore, apparently not accounted for so much by their rapidity of multiplication as by their unusual ability to preserve themselves from ordinary means of destruction and by the scarcity of natural enemies."

**P. australasiæ** Fabricius. Australian Roach.

This cockroach is slightly smaller and darker colored than the above species. It is readily distinguished by the yellow stripe on the basal half of the outer margin of the tegmina.

Measurements.

| | Body | Pronotum | | Tegmina |
|---|---|---|---|---|
| | | Length | Width | |
| Female | 23 | 7 | 9.5 | 22 |
| Male | .. | .. | .. | .. |

New Haven, August (D. B. Pangburn); Wallingford, 5 August (D. J. Caffrey).

It will probably be found in most cities, especially those along the coast. The Australian roach is very abundant in the South, where it is a greater pest than either of the other members of this sub-family.

## MANTIDÆ.

The large insects of this family will be readily recognized by the long prothorax, and the first pair of legs which are fitted for grasping. The pronotum is the longest segment of the body. Head large, triangular, and so joined to the prothorax that it is freely movable. Antennæ slender, shorter than the body. The abdomen of the male is much more slender than that of the female. The fore legs are very stout, spiny, and terminating in a single claw which, with the five-jointed tarsus, folds into a groove on the under side of the tibia. The other legs are long and slender. Tegmina and wings are present, those of the female often rudimentary.

The mantids differ from all of the other members of the order in that they are beneficial, feeding largely on other insects. These insects are often called "praying mantids" from the prayerful attitude which they assume with their folded fore legs when at rest or waiting for some insect to come within their reach.

These introduced insects will be readily recognized from the illustrations on plate VI, and are readily distinguished by their relative size.

**Tenodera sinensis** Saussure. Chinese Mantis. Plate VI, 1.

This large Chinese insect was first brought to our attention by an egg-mass received from a nursery in New Haven. The egg-mass was sent Feb. 1, 1902, and was found upon *Ilex crenata* which had been imported direct from Japan the previous spring. Another egg-mass was found in this nursery during the summer of 1903, indicating that the species had lived through the winter.* An adult female of this species was taken near Philadelphia, October 16, 1897, in the vicinity of large nurseries which imported considerable stock. It soon became thoroughly established, and in 1902 nearly half a barrel of the egg-masses were collected for distribution. A number of egg-masses were brought from Philadelphia to Connecticut in the winter of 1903, but, while a few of these hatched, it is not thought that any reached maturity. The following winter about twenty-five more egg-masses were obtained and distributed in five different localities. About a dozen adult specimens in all were seen in three of these localities the following fall, and in one of these localities a few adults were found the second season. This shows that the insect will live through our winters, but it is doubtful if it has become thoroughly established in the state.

Measurements.

| | Body | Tegmina | Pronotum | Fore Femora | Fore Tibiæ | Hind Femora |
|---|---|---|---|---|---|---|
| Male | 87 | 61 | 23 | 14 | 18 | 26 |

**Mantis religiosa** Linnæus. European Praying Mantis. Plate VI, 3.

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* See III Report, Conn. State Entomologist, 1903, p. 213.

This is a European species which was found in New York state near Rochester in 1899,* and has since become well established in that vicinity. This was probably also introduced with nursery stock. As this species often lays its egg-mass on the stems of grass, it has been suggested that an egg-mass might have been in the hay which is often used for packing when shipping nursery stock. Egg-masses of this species were obtained in 1903, and brought to Connecticut, but they failed to hatch.

## PHASMIDÆ.

This family contains the insects known as "walking-sticks." The body is very long and nearly cylindrical. The head is not covered by the pronotum. The eyes are small, the ocelli often wanting. Tegmina and wings are wanting in the species of the United States. The legs are long and slender, nearly equal in size. The tarsi are usually five-jointed and terminate with claws.

The *Phasmidæ* are best represented in the tropics where forms are found with large wings, one species especially being remarkable for its close resemblance to a leaf. The species of the United States, which are confined largely to the southern states, are wingless and mimic the twigs on which they feed. Despite the fact that these insects are very slender and have long legs, they are awkward and sluggish in their movements, and depend largely upon their protective resemblance to escape detection. The eggs of these insects are dropped singly upon the ground in the fall, where they remain unprotected through the winter. These usually hatch irregularly through the first season, and it is stated that some may not hatch until the second season.

### **Diapheromera** Gray.

Head smooth, oval or sub-quadrate, and obliquely attached to the thorax. Antennæ exceeding twice the length of the anterior femora. The first segment of the thorax less than one-fourth the length of the second and third, which are about equal in length. Body long, slender, and cylindrical, "stick-like," that of the male terminating in cylindrical, incurved cerci, longer than the last abdominal segment. Legs very slender, the middle femora of the male much swollen, and with a sharp spine at the apex of the under side of both the middle and hind femora, which is less prominent in the female.

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* Cornell University Experiment Station, Bull. 185, 1900.

One species of this genus occurs throughout the northern United States east of the Rocky Mountains and is represented in Connecticut.

**D. femorata** Say. Northern Walking-stick. Plate VII, 7.

Color of the male usually greenish brown, sometimes almost entirely green. Head yellowish, with three more or less distinct longitudinal fuscous stripes. The female more often grayish brown, more or less mottled with lighter specks. The male is readily distinguished by the more slender body, the less dilated fore femora, the more swollen middle femora, and the stouter spines near the tips of the middle and hind femora. The middle femora of the darker males are banded with lighter color.

Measurements.

| | Body | Antennæ | Hind Femora |
|---|---|---|---|
| Female | 84 | 64 | 18 |
| Male | 70 | 62 | 18 |

This curious insect is probably well distributed throughout the state and is sometimes locally abundant, but the ordinary observer will seldom see more than one or two specimens in a year, owing to its protective resemblance to twigs and its habit of remaining quiet for long periods. It is often taken in sweeping low bushes, the hazel apparently being one of its favorite food plants. The northern walking-stick is the most common species in the United States and the only one of economic importance. It has been recorded as defoliating considerable tracts of woodland, oak and wild cherry usually being attacked first. Ordinarily it is not abundant enough to do much damage. Burning the ground in the fall to destroy the eggs is the remedy suggested.

## SALTATORIA.

The *Orthoptera* belonging to this sub-order have the hind pair of legs greatly enlarged and fitted for leaping. In the winged forms the males are provided with calling organs, and both sexes possess auditory or hearing organs. The wingless forms lack both the calling and hearing organs. Three families are included here which contain the majority of our well-known insects of the order *Orthoptera*.

### *Key to Families.*

1. Antennæ much longer than the body, very slender, tapering. Ocelli often wanting, tarsi three- or four-jointed. Hearing organs usually near the base of the fore tibiæ. Ovipositor usually much elongated..... 2

Antennæ much shorter than the body, ocelli three. Tarsi three-jointed. Hearing organs when present situated on the sides of the basal joint of the abdomen. Ovipositor consisting of two pairs of short, horny plates, more or less curved, with the tips diverging .......................ACRIDIDÆ p. 63

2. Tarsi four-jointed. Ocelli generally absent. Tegmina with the sides sloping. Ovipositor usually in the shape of a flattened, sword-shaped blade, the tip not expanded .......................LOCUSTIDÆ p. 123

Tarsi three-jointed. Ocelli variable. Tegmina flattened above, with the sides bent abruptly downward. Ovipositor usually exserted and consisting of a nearly straight or upcurved needle, the tip often enlarged GRYLLIDÆ p. 147

## ACRIDIDÆ.

This family contains the short-horned grasshoppers which are properly termed "locusts." In Connecticut they are ordinarily called simply "grasshoppers." Their numbers outrank those of the other families.

The *Acrididæ* are readily distinguished from the other families by the antennæ, which are shorter than the body. They may be filiform, ensiform, or rarely clavate. The joints are distinct and are often flattened towards the base. The head is usually short and extended horizontally. The ocelli are present and three in number. The foveolæ are usually present, their size and shape furnishing characters used in classification. The pronotum is somewhat saddle-shaped, and usually covers the three thoracic segments, though in the *Tettiginæ* it extends back over the abdomen. The tegmina and wings when present and closed are partly extended horizontally along the top of the abdomen and partly deflected against the sides. The hearing organ when present is situated on the side of the first basal segment of the abdomen. The fore and middle pairs of legs are nearly equal in size. The hind pair are much longer, with the femora greatly enlarged for leaping. The tarsi of all the legs are similar — three-jointed, with a pair of curved claws on the tip of the apical joint. Between these claws, excepting in the *Tettiginæ,* is a small pad called the pulvillus or arolium. The ovipositor consists of four horny plates, one pair curving upward and the other pair curving downward. In the male the lower appendage consists of a single plate.

The males only are furnished with stridulating or sound-producing organs. The sound is produced in two ways. In one group the sound or call is made only when the insects are at rest, and is produced by rubbing the inner surface of the hind femora over the upper surface of the tegmina.

" Landois has shown that in this group the inner surface of the femur is furnished, along the lower margin, with a longitudinal row of minute, lancet-shaped, elastic teeth, ranging in number from 85 to 93, which are scraped across the veins of the tegmina, thus producing a low, buzzing sound. Those which stridulate in this manner mostly belong to the sub-families *Tryxalinæ* and *Acridinæ.*

" The members of the sub-family *Œdipodinæ* usually sound their call during flight by rubbing together the upper surface of the front edge of the wings and the under surface of the tegmina, thus producing a sharp, crackling sound which has been likened to that of burning stubble. By paying close attention the observer can soon learn to know each species by its peculiar call." — Blatchley.

### *Key to Sub-families.*

1. Size large; pronotum not extending over the abdomen; claws of tarsi with pads between them............ 2

Size smaller; pronotum extending back over the abdomen; claws of tarsi without pads (pulvilli) between them ............................TETTIGINÆ p. 65

2. No spine between the front pair of legs.............. 3
   A prominent conical spine between the front pair of legs ..............................ACRIDINÆ p. 106
3. Face usually very oblique; foveolæ usually well developed; median carina of the pronotum never raised in the form of a crest or with more than one notch TRYXALINÆ p. 71
   Face or front of the head more vertical and more rounded than above; foveolæ not well developed; median carina of pronotum usually raised in the form of a crest and usually cut by more than one notch ŒDIPODINÆ p. 86

### TETTIGINÆ.

The Tettiginæ or "grouse locusts," as they are often called, are the smallest members of the *Acrididæ*. At first glance they might be taken for immature grasshoppers, but they can be readily distinguished by the pronotum which extends to or beyond the extremity of the abdomen. The tegmina are only rudimentary and consist of small scales at the base of the wings. The wings are usually large and well developed. No pads are present between the claws of the tarsi.

The grouse locusts are the only members of our *Acrididæ* which pass the winter as adults, hibernating under rubbish, fence rails, pieces of bark, etc. They are, therefore, the first Acridians to appear early in spring, being most numerous at this season and in the fall, though some species can be found nearly every month in the year. The dry, sunny hillsides of a pasture seem to be the favorite haunt of some species, while others prefer moist, boggy land or the margins of lakes and streams. Their color and variable markings harmonize perfectly with the surroundings, making them very inconspicuous. Indeed, it is seldom that they are seen unless one is searching for them.

### *Key to Genera.*

1. Antennæ with 12 to 14 joints...................... 2
   Antennæ with 21 or 22 joints............**Tettigidea** p. 70
2. Median carina high, crest-like, arched longitudinally. Superior lateral sinus of pronotum shallow, about one-half as deep as the inferior (Fig. 6)........ **Nomotettix** p. 66

Median carina low, dorsum rather flat. Superior lateral sinus of pronotum nearly as deep as the inferior (Fig. 9) .................................... 3

3. Vertex of head projecting beyond eyes (Fig. 8).... **Tettix** p. 67

Vertex of head not projecting beyond eyes (Fig. 11) **Paratettix** p. 69

### **Nomotettix** Morse.

Head with the vertex projecting beyond the eyes and wider than one of them, the front border rounded. Front of vertex when viewed from the side sub-rounded, with a deep notch in front of eyes. Top of head with a pair of nipple-like tubercles between the posterior portion of the eyes. Pronotum with the median carina high, longitudinally arched, and usually extending only to the end of abdomen, with the inner wings rudimentary. Rarely the pronotum is prolonged and the inner wings well developed.

**N. cristatus** Scudder. Plate VII, 8.

This species is our smallest Acridian and will be readily recognized by the high arched pronotum. The hind femora are

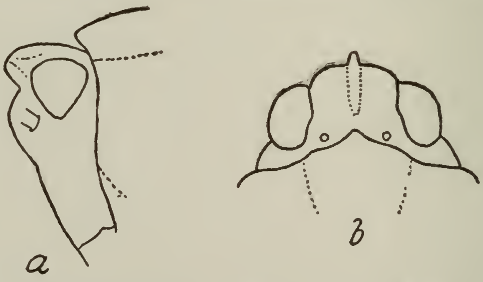

FIG. 5. *Nomotettix cristatus.* Lateral and dorsal views of head.

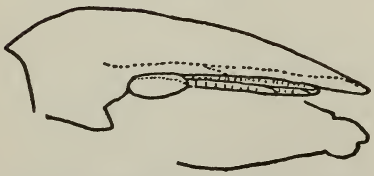

FIG. 6. *Nomotettix cristatus.* Lateral view, showing crest of pronotum and sinuses of lateral lobes.

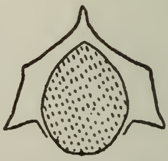

FIG. 7. *Nomotettix cristatus.* Cross section of body.

stouter than in the species of *Tettix*. The color may be a uniform grayish brown or the pronotum may be strikingly marked with a design of velvety black. This is the most common of our grouse locusts, and is found all over the state in dry pastures and on hillsides where the soil is light and the vegetation is scant. It can probably be found in every month of the year.

Measurements.

| | Total length | Pronotum |
|---|---|---|
| Female | 8.6-10.2 | 8 -9.5 |
| Male | 7.7- 9 | 7.1-8.5 |

From various parts of the state from 27 April to 2 October.

**N. cristatus**, var. **carinatus** Scudder.

In the form *carinatus* the pronotum is prolonged and slightly upturned at the end. The inner wings are also developed.

Measurements.

| | Total length | Pronotum |
|---|---|---|
| Female | 11-12.5 | 9.8-11.5 |
| Male | 11-11.5 | 9.5-10.7 |

Quite rare; the collection contains two specimens as follows:—West Haven, 11 May, Scotland, May (B. H. W.).

### **Tettix** Charpentier.

This genus has the vertex of head projecting beyond the eyes. Dorsum or top of pronotum flat. Median carina distinct but not prominent. Superior lateral sinus nearly as deep as the inferior. Wing covers in form of oval scales. Wings well developed, usually as long or longer than the abdomen.

*Key to Species.*

Vertex with front margin rounded, median carina projecting (Fig. 8) .................................**ornatus**

Vertex with front margin angulate, median carina not projecting (Fig. 10) ............................**granulatus**

**T. ornatus** Say. Plate VII, 9.

This species varies greatly in structure, color, and markings, but can be readily distinguished by the characters given above. A short-winged form was described as *T. triangularis*, but a large series of specimens will usually grade from the typical form of *ornatus* to the typical *triangularis,* showing that the latter is but an extreme variation.

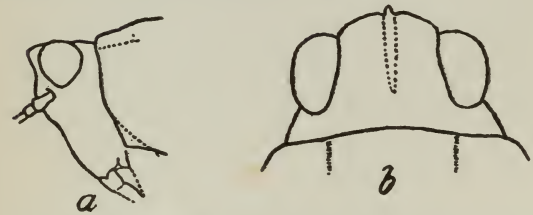

FIG. 8. *Tettix ornatus.* Lateral and dorsal views of head.

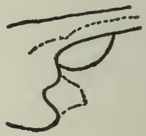

FIG. 9. *Tettix ornatus.* Sinuses of lateral lobes of pronotum.

Measurements.

| | Length | Pronotum |
|---|---|---|
| Female | 9 -13.5 | 8 -12 |
| Male | 8.3-12.5 | 7.5-11 |

Rather common in spring and fall. Frequents moist meadows and the more moist portions of uplands. New Haven, 29 August (A. P. M.); Mt. Carmel, 4 November (E. J. S. M.); Woodbridge, 16 April, New Haven, 2, 24 May, Middletown, 22 September, New Canaan, 4 October (W. E. B.); New Haven, 26 April, 17 May, 4 June, 17 August, 10 September, Scotland, 2 September (B. H. W.).

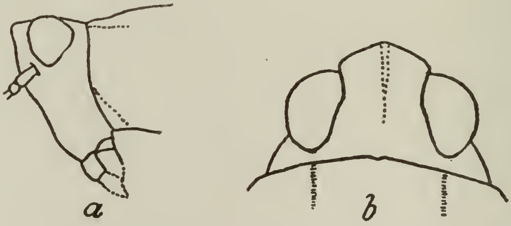

FIG. 10. *Tettix granulatus.* Lateral and dorsal views of head.

T. granulatus Kirby.

Rather more slender and eyes less prominent than in the previous species. Vertex angulate with the median carina very slightly advanced. Pronotum and legs finely granulated.

Measurements.

| | Length | Pronotum |
|---|---|---|
| Female | 13.5-15.3 | 12 -15-5 |
| Male | 9.7-13.5 | 8.6-11.5 |

Said to be one of the most common and widely spread species of the group, and found in similar locations to *ornatus.* I have taken *ornatus* much more frequently. New Haven, 4 June, 20 August, Centerville, 10 May, Lyme, 20 August (B. H. W.).

### **Paratettix** Bolivar.

The members of this genus are distinguished by the short and narrow vertex which is not projected beyond the eyes. Eyes prominent, antennæ with 14 joints. Pronotum with the dorsum flat, front margin truncate. Tegmina in form of oval scales. Wings usually well developed.

**P. cucullatus** Burmeister. Hooded Grouse Locust.

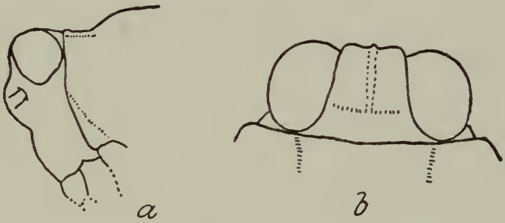

FIG. 11. *Paratettix cucullatus.* Lateral and dorsal views of head.

This species is readily recognized by means of the key and the above description. Color a uniform yellowish to grayish brown. Vertex from above but little wider than one of the eyes, which are large and prominent. Pronotum truncate in front and extending forward to the eyes.

Measurements.

| | Length | Pronotum |
|---|---|---|
| Female | 13.5-15.5 | 11 -13 |
| Male | 11 -13.5 | 9.5-11 |

This species is very local in its distribution, occurring along the shores of ponds and streams. Canaan, 18 August (1 female), Thompson, 13 July (scarce), August 4-9 (very scarce), New Haven, 27 August (abundant) (A. P. M.); East Hartford, 13 August (1 male) (B. H. W.).

Morse states, "The Thompson and Canaan specimens were found in the sandy mud of a lake shore, and were yellowish-gray; the others on a margin of a little stream strewn with fragments of blackened wood and other waste, and were very dark." The East Hartford specimen was taken near a small pond in a large excavated area and was of the grayish brown color of the soil.

### Tettigidea Scudder.

More robust and clumsy than previous genera. Head larger and face less oblique. Antennæ with 22 joints. The top of the head with a small lobe on either side which projects upon the upper inner border of the eyes. Vertex wider than one of the eyes. Pronotum with the dorsal surface usually finely wrinkled, the sides sloping downward between the shoulders, the rear portion flat.

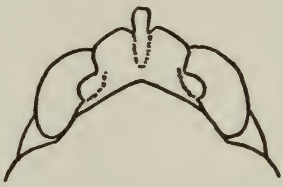

FIG. 12. *Tettigidea parvipennis.* Dorsal view of head.

**T. parvipennis** Harris. Plate VII, 10.

Grayish or light brown above, sides darker. Male with the lower part of the face and the front portion of the lower part of the sides of the pronotum whitish. The pronotum with the median carina distinct, the posterior portion slightly passing the tip of the abdomen, with the wings abortive, or, in the form *pennata,* passing the tip of the hind femora, and with the wings developed.

Measurements.

| | Total length | Pronotum |
|---|---|---|
| Female | 11.5-14 | 10.4-13 |
| Male | 8.4-11.5 | 8 -11 |

**T. parvipennis pennata** Morse.

Measurements.

| | Total length | Pronotum |
|---|---|---|
| Female | 15-16.8 | 13.3-14.6 |
| Male | 11.5-13 | 9.8-11.5 |

The short-winged form is rather more numerous, though neither is very abundant. The species occurs in moist or wet boggy meadows, especially on light soil, and along wet, sandy roadside gutters. Canaan, North Haven, South Kent, Stamford, Thompson (A. P. M.); Woodbridge, 16 April, Kent, 31 August (W. E. B.); West Haven, 27 June (H. L. V.); New Haven, 26 April, 15, 17 May, Scotland, 25-27 July, Meriden, 29 April (B. H. W.).

### TRYXALINÆ.

In the *Tryxalinæ* the vertex of the head is nearly horizontal, the face quite oblique, generally forming an acute angle at the union with the vertex. Lateral foveolæ are usually well developed, though sometimes absent. The eyes are usually longer than that portion of the cheek below their orbits. The antennæ are variable, being acuminate, depressed, or rarely clavate, and situated between or below the middle of the eyes. The pronotum has the front and rear margins of the disk nearly equal in width; all the carinæ are usually distinct, the median carina cut by one sulcus and not raised in the form of a crest. The tegmina and wings are often short and rudimentary, but sometimes fully developed in members of the same species. The inner wing is usually transparent, without bright colors or a black band.

#### *Key to Genera.*

1. Antennæ distinctly ensiform (Fig. 13). Face very oblique .................................... 2
   Antennæ not ensiform. Face less oblique............ 3
2. Prosternum with obtuse tubercle.....**Pseudopomala** p. 73
   Prosternum without tubercle..............**Tryxalis** p. 72
3. Antennæ linear. Spurs on inner side of posterior tibiæ about equal .................................... 4
   Antennæ slightly clavate (Fig. 16). Apical spur on inner side of posterior tibiæ twice as long as the other spur ..................................**Eritettix** p. 74
4. Foveolæ of the vertex wanting or not visible from above 5
   Foveolæ of the vertex visible from above (Fig. 24).. 9
5. Antennæ short, about equal to head plus pronotum. Tegmina with scapular area not dilated............ 6
   Antennæ long, depressed, from one and one-half (male) to twice (female) as long as head plus pronotum. Scapular area of tegmina dilated (Fig. 23)......... **Chloealtis** p. 82

6. Sides of pronotum elongated, the length on dorsal margin greater than the depth (Fig. 18a)......... 7
Sides of pronotum not elongated (Fig. 18b)........ 8
7. Sides of pronotum nearly vertical, flat above, lateral carinæ parallel throughout (Fig. 17a)............. **Dichromorpha** p. 76
Sides of pronotum convex above, lateral carinæ slightly divergent behind (Fig. 17b).......**Clinocephalus** p. 77
8. Lateral carinæ more or less divergent before and behind (Fig. 20). The middle foveolæ usually present on front edge of vertex (Fig. 21).....**Orphulella** p. 78
9. Tegmina without well developed intercalary vein. Median carinæ of pronotum not high or sharp, and not cut in front of middle by principal sulcus........ **Stenobothrus** p. 83
Tegmina with well developed, elevated, intercalary vein. Median carina of pronotum rather high and sharp, cut plainly in front of middle by principal sulcus (Fig. 25) ........................**Mecostethus** p. 84

### **Tryxalis** Fabricius.

Head with the vertex horizontal, the front rounded and projecting beyond the eyes to the distance between the eyes. Median carina faint. Lateral foveola absent. Face very oblique. Antennæ flattened at the base, tapering to a point, and about as long as the head plus the pronotum. Pronotum with the disk flat, the median and lateral carinæ distinct and parallel. Median carina cut behind the middle. Lateral lobes of the pronotum parallel and perpendicular, slightly longer than high, the front and hind margins sloping towards each other ventrally. Wing covers usually extending much beyond the end of the abdomen. Hind femora long and slender. Tibiæ with only twelve spines on exterior margin.

**T. brevicornis** Linnæus. Short-horned Locust. Plate VII, 12.

The females are usually either pale green dotted with brown, or pale brown. The males are much smaller and usually have the dorsal surface, face, fore and middle legs, and face of hind femora green with the remainder of the body brown. Hind wings transparent with greenish veins.

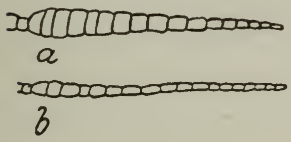

FIG. 13. *a*. Antenna of *Pseudopomala brachyptera*.
*b*. Antenna of *Tryxalis brevicornis*.

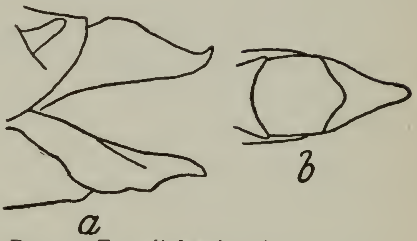

FIG. 14. *Tryxalis brevicornis*.
*a*. Lateral view of tip of female abdomen.
*b*. Ventral view of tip of male abdomen.

Measurements.

| | Length of Body | Antennæ | Tegmina | Hind femora |
|---|---|---|---|---|
| Female | 33 | 11 | 30 | 20 |
| Male | 20 | 10 | 20 | 14 |

We have no record of the capture of this insect in Connecticut. It is a more southern species, but has been taken on Long Island and should be looked for in late summer on the rank weeds and grasses in wet places throughout the southwestern part of the state.

### **Pseudopomala** Morse.

Body long and slender. Head with the vertex horizontal in the female, slightly ascending in the male, and projecting in front of the eyes to a distance equaling its width, and with its anterior margin elongately rounded. The median carina more prominent than in *Tryxalis*. Antennæ ensiform (Fig. 13). Face very oblique, frontal costa prominent, slightly sulcate with the sides nearly parallel. Pronotum about twice as long as broad, the front margin truncate. The disk slightly roof-shaped with lateral carinæ parallel. Prosterum bearing an obtuse tubercle. Tegmina usually abbreviated. Hind femora slender, those of the male with a long, stridulating rasp of fine teeth. Hind tibiæ with 12 to 19 spines on exterior margin. Apical spine absent.

**P. brachyptera** Scudder. Plate VII, 11.

Light brown with darker brown dots and longitudinal markings. Tips of antennæ, hind tibiæ, and tibial spines more or less infuscate. Tegmina of male with apical two-thirds nearly transparent, those of the female opaque.

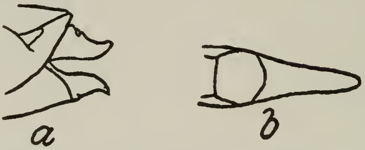

FIG. 15. *Pseudopomala brachyptera.*
*a.* Lateral view of tip of female abdomen.
*b.* Ventral view of tip of male abdomen.

Measurements.

| | Body | Antennæ | Tegmina | Hind femora |
|---|---|---|---|---|
| Female | 27.5-29.5 | 8.5-10 | 7 -12 | 14 -19 |
| Male | 23.5-27 | 9.5-11.5 | 9 -12.3 | 13.5-15.5 |
| Long-winged female | | | 18 -22 | |
| Long-winged male | | | 15.5-17 | |

This odd-looking insect is sometimes locally common on light waste lands. It is sluggish in its movements and is usually found clinging to the stems of grass, especially the bunch grass, *Andropogon scoparius.* It attempts to escape notice by slipping around to the opposite side of the stem. Canaan, North Haven, Thompson (A. P. M.); Scotland, 25 July-10 August, Plainfield, 14 August (B. H. W.); West Woodstock, September (W.B.).

### **Eritettix** Bruner.

Head with the occiput moderately rounded. The vertex subtriangular, the front rounded. Lateral carinæ usually distinct, sometimes appearing as heavy raised lines. The median carina extends from the pronotum to the front of the vertex. There are also two supplementary carinæ extending from the pronotum to a point opposite the front margin of the eyes where each is sharply bent to meet the lateral carinæ (Fig. 16). Frontal costa gradually divergent, a little constricted about the ocellus and slightly sulcate from the ocellus part way to the vertex. Antennæ somewhat flattened basally and clavate apically. Pronotum with the median and lateral carinæ distinct, cut behind the middle, also a supplementary carina on either side about midway between the median and lateral carinæ. Lateral lobes about as high as long, the front and posterior margins nearly straight, the former rather more oblique. Tegmina and wings usually well developed. Posterior femora stout, unbanded, and extending to end of abdomen in female, beyond in male.

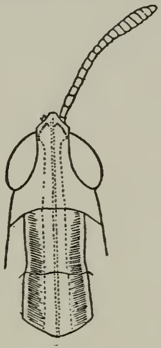

FIG. 16. *Eritettix carinatus.*
Dorsal view of head and pronotum of male.

**E. carinatus** Scudder.

This is a very pretty species; the two females in our collection are as follows: — General color grayish brown, dorsal field of pronotum with a narrow line of white extending along either side just above the lateral carinæ. Between this line and the supplementary carinæ is a broad band of velvety brownish black which is extended along the top of the head nearly to the vertex, its outer edge narrowed by the upper border of the eye. The central portion of the top of the pronotum between the supplementary carinæ and extending to the front of the vertex is grayish brown. Wing covers not reaching the end of the abdomen; with an indistinct dark median stripe, below which, extending along the basal half of the wing cover, is a greenish white stripe. Hind femora without markings, reaching to the end of the abdomen. The males are darker, with markings less distinct. The wing covers surpass the end of the abdomen by about 3 mm. and the hind femora reach about half-way between the end of the abdomen and the end of the wing covers.

Measurements.

| | Body | Antennæ | Tegmina | Hind femora |
|---|---|---|---|---|
| Female | 23 | 5.5 | 13.5 | 12 |
| Male | 16 | 5 | 12.5 | 10 |

Scudder gives the Middle States as the locality for this species, and our Connecticut records for this species, published in *Psyche,*[*]

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[*] *Psycne*. Vol. XI, p. 23, 1904.

were the first ones for New England. It occurs on light dry soil where there is but little vegetation. Two of the specimens captured by the writer were taken in abandoned fields, and the third in a dry pasture. New Haven, 16 June, Mt. Carmel, 31 October, Orange, 2 November (nymphs) (E. J. S. M.); East Haven, 31 May (M. Hebard); Centerville, 25 May to 8 June, Southington, 30 June (B. H. W.).

### **Dichromorpha** Morse.

Vertex much shorter than broad. Lateral carinæ elevated and meeting in front in a blunt point. Median carina and lateral foveolæ absent. Antennæ slightly flattened, about the length of the head plus the pronotum. Dorsal surface of the pronotum flat, with the three carinæ straight and parallel, cut behind the middle by the principal sulcus. Sides of the pronotum perpendicular, longer than deep. Tegmina rarely reaching the end of the abdomen. Hind femora stout, not banded.

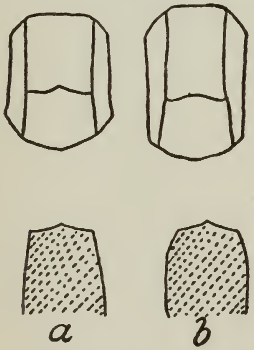

FIG. 17. *a. Dichromorpha viridis.*
*b. Clinocephalus elegans.*
Disk and cross section of pronotum.

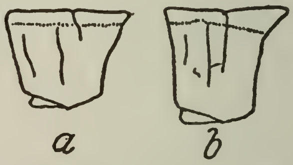

FIG. 18. *a. Dichromorpha viridis.*
*b. Orphulella pelidna.*
Lateral view of pronotum.

**D. viridis** Scudder. Short-winged Green Locust. Plate VIII, 1.

This species is dimorphic as regards form and color. The male is nearly always green above and dull brown below. Rarely males occur which are brown above. The females are either bright green or dull brown. Tegmina ovate lanceolate, about one-half the length of the abdomen in the female, three-fourths in the male. Hind femora reaching the end of the abdomen in the female and extending beyond about one-fourth their length in the male.

Occasionally in the female the tegmina reach the end of the abdomen. This form has been named *punctulata,* and may be either green or brown, the former color predominating. *Punctulata* males are very rare. The collection contains two males with the tegmina longer than any that the writer has seen recorded.

Measurements.

| | Body | Antennæ | Tegmina | Hind femora |
|---|---|---|---|---|
| Female | 23-27 | 7 -8 | 8-10 | 14 -15 |
| Male | 15-16 | 6.5-8.5 | 6- 9 | 9.5-10.5 |
| Long-winged form | | | | |
| Female | | | 19 | |
| Male | | | 14 | |

A common species. Delights in moist places where the grass is luxuriant and green throughout the season. Taken in various parts of the state from 17 July until 23 October.

### **Clinocephalus** Morse.

Vertex shorter than broad, lateral carinæ elevated and meeting in front in a blunt point. Median carina and lateral foveolæ not present. Antennæ slender, longer than the head plus the pronotum (male), or as long as the head plus the prozona (female). Pronotum with the disk nearly flat, the three carinæ well developed, the lateral carinæ parallel on the prozona, slightly divergent on the metazona, cut behind the middle by the principal sulcus. Sides of the pronotum longer than deep, perpendicular below, convex on the upper third. Tegmina nearly or quite reaching the tip of the abdomen. Hind femora slender, not banded.

"This genus occupies an intermediate place between *Dichromorpha* and *Orphulella,* and is closely related to the former, from which it differs especially in having the sides of the pronotum convex below the lateral carinæ, which, in addition, are slightly divergent on the metazona."

**C. elegans** Morse. Fig. 17.

The general color varies from light olivaceous green to dark greenish brown. A dark brown or blackish stripe reaching from the posterior border of the eye along the upper part of the lateral lobes of the pronotum and sometimes to the humeral field of the tegmina; sometimes this band is faint. The female may be taken for that of *Stenobothrus curtipennis* but is readily distinguished by the absence of foveolæ and the more elongated pronotum with the less divergent lateral carinæ.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 20.5-23 | 5 | 12 | 12.3 |
| Male | 17 | 7.5-8 | 10.5 | 10 |

This species has not been taken in Connecticut, but occurs in New Jersey, and should be looked for in the southern part of the state.

### **Orphulella** Giglio-Tos.

Vertex nearly horizontal, not extending beyond the eyes for a distance greater than its width. Median carina, if present, very faint. Lateral foveolæ small and not visible from above. Pronotum with the median carina sharp, cut either at or behind the middle. The lateral carinæ divergent before and behind the middle. Lateral lobes of pronotum as broad as long; front border moderately oblique; hind border less oblique and slightly sinuate. Tegmina and wings well developed. The tegmina narrow, little shorter than the abdomen in some species and considerably longer in others. Hind femora of medium size, often banded.

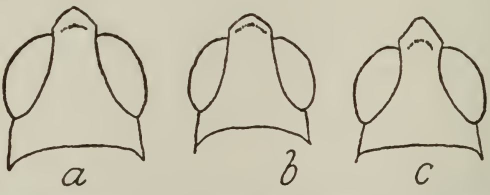

FIG. 19. *a. Orphulella pelidna. b. Orphulella speciosa. c. Orphulella olivacea.*
Dorsal view of head of male.

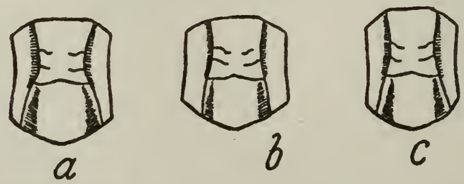

FIG. 20. *a. Orphulella pelidna. b. Orphulella speciosa. c. Orphulella olivacea.*
Disk of pronotum, female.

Three species are found in Connecticut. These are difficult to determine, as individuals of the same species vary greatly in color, markings, and even structure.

*Key to Species.*

Vertex of head about right-angled or a little acute in the male, slightly narrowed between the eyes. The central depression back one-fourth to one-third the width of the vertex. Lateral carinæ of pronotum strongly incurved and the distance between them at hind margin much greater than at front margin. Median carina cut at middle. Tegmina usually surpassing hind femora (Figs. 19a and 20a) .......... **pelidna**

Vertex of head blunt, rounded, obtuse in the female, right-angled in the male, scarcely narrowed between the eyes. The central depression close to apex. Lateral carinæ of pronotum little incurved, the distance between them but little greater at hind margin than at the front. Median carina cut back of the middle. Tegmina about reaching end of hind femora, often shorter, rarely surpassing it (Figs. 19b and 20b) ........................................ **speciosa**

Vertex of head acute, the sides often incurved in the males, distinctly narrowed between the eyes. Central depression back from the apex about one-half the width of the vertex. Lateral carinæ of pronotum little incurved, the distance between them much greater at hind margin than at the front. Median carina cut back of the middle. Tegmina usually extending beyond the hind femora (Figs. 19c and 20c) .... **olivacea**

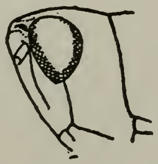

FIG. 21. *Orphulella pelidna*, female. Lateral view of head.

**O. pelidna** Burmeister. Figs. 19a and 20a.

Head with the vertex raised above the disk. Median carina absent. Foveolæ distinct, narrowly triangular. Frontal costa rounded at the union with the vertex. The hind femora of the female usually slightly exceeding the end of the abdomen, those of the male extending about 2 mm. beyond. The tegmina always reach to the end of the hind femora, and usually pass it from 1.5 to 3 mm. in the female and from 1 to 4.5 mm. in the male. Tegmina with a median band of square black spots, and with the sides nearly parallel. Color is variable, brownish specimens being most common. The top of the head and pronotum and the median and dorsal portion of tegmina may be brown, rose-red, or green. Bright green males are rather rare. The top of the head and pronotum often have a pair of velvety, brownish-black stripes, with the carinæ whitish. There is usually a dark band from the rear of the eyes along the top border of the lobes of the pronotum, and a blackish triangular patch on either side of the disk of the metazona next to the lateral carinæ. Specimens thus marked appear at a glance as belonging to a species entirely different from the individuals with a solid color on the upper surface.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 16.5-23.5 | 5.5-7 | 13.5-20 | 10.5-12.5 |
| Male | 14.5-15.5 | 4.7-6.5 | 12.5-16.5 | 8.5- 9.8 |

This species occurs from the middle of July until about the middle of September, and Morse states that it is found on the drier portions of the land adjoining the salt marshes, on the more densely grassed portions of ground just inshore of the sandy beaches, and on loamy or sandy soil further inland. Some of the inland records are as follows: — Montville, Thompson (A. P. M.); Scotland, 27 July to 10 August, Canterbury, 14 August (B. H. W.).

**O. speciosa** Scudder. Plate VIII, 2. Figs 19b and 20b.

Head with the vertex more blunt than in *pelidna*. Margins of vertex less raised. Foveolæ less distinct. The disk of the pronotum more nearly equal in width at the anterior and posterior margins and the sides less constricted at the middle than in the two other species. The principal sulcus cuts the disk somewhat behind the middle. The tegmina usually reach about to the end of the hind femora, though they vary from 1.5 mm. short of the end of the femora to 2 mm. beyond in the female, and in the male from 3 mm. short of the end to 3 mm. beyond. The tegmina taper slightly towards the apex. The color of this species is even more variable than in *pelidna,* having not only the same color forms as the latter, but many intermediate shades. Morse gives the more striking variations as follows:

| | Head | Pronotum | Tegmina |
|---|---|---|---|
| 1 | Green | Green | Green |
| 2 | Green | Green | Rose-red |
| 3 | Brown | Brown | Rose-red |
| 4 | Brown | Brown | Brown. |

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 16-21.5 | 5 -6.5 | 9-16 | 9.5-12 |
| Male | 13-14 | 4.5-6.5 | 10-13.3 | 8.5-10 |

This species, which is one of the most abundant species of *Tryxalinæ,* is found throughout New England, while the other two species occur principally in the southern part. *Speciosa* is found on rather light soil of pastures and cultivated fields. We have taken specimens in various parts of the state from 19 July to 3 October.

**O. olivacea** Morse. Figs. 19c and 20c.

Allied to *pelidna.* Aside from the differences in the key the vertex is more nearly horizontal and meets the front at a sharper angle. The face is more oblique and the antennæ shorter. The pronotum is longer and the prozona wider, with the lateral carinæ less incurved and forming straight lines rather than curves. It differs from *speciosa* in having the lateral carinæ strongly divergent on the metazona, making the disk much wider at the posterior margin than the anterior. The tegmina surpass the hind femora by at least 2 mm., tapering somewhat towards the apex. The color is more uniform than in the other two species, being in general pale brown to dark olive brown, or light green above and pale brown below. Darker markings more or less similar to those of other species. The colors have a peculiar olivaceous tinge which corresponds to the tints of the vegetation where it is found. *Olivacea* is somewhat the largest of the three species.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 21-25 | 6 | 17-21 | 12.5-14 |
| Male | 16.5-18.7 | 6-7 | 14-17 | 10 -10.5 |

This species was described by Prof. Morse from specimens which he took at Greenwich and Stamford, August 11th to 28th. It has also been taken at New Haven (B. H. W.). In regard to its occurrence Morse says, "This species, though not widely spread, was locally very plenty in the salt marshes, its green and olivaceous tints closely matching in color the marsh grasses in which it made its home. The ground beneath was often overflowed at high tide and offered a retreat to myriads of fiddler crabs, being much wetter and of a wholly different character from the situations frequented by *pelidna* and *speciosa*."

### **Chloealtis** Harris.

Head with the vertex triangular, the margins but little raised. Median carina faint, but present. Foveolæ absent. Antennæ flattened at base, nearly one and one-half times (females) or twice (males) the length of head and pronotum. Pronotum with the three carinæ present and cut much behind the middle by the principal sulcus. Lateral carinæ but little incurved in the male, slightly more so in the female. Lateral lobes of the pronotum a little longer than deep, the front and hind margins straight, both strongly and equally oblique. The lower margins with the back portion nearly horizontal and the front portion ascending. Tegmina of female usually abbreviated and wings abortive, while those of the male are well developed, with the scapular area well developed and with many cross veins. Hind femora of medium size and banded on the upper face. Ovipositor short, the upper valves enlarged and strongly toothed at base (Fig. 22).

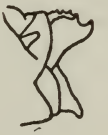

FIG. 22. *Chloealtis conspersa*, female. Tip of abdomen, from side.

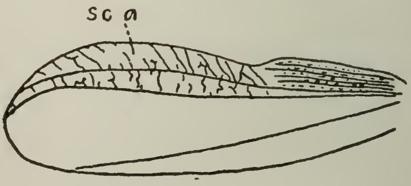

FIG. 23. *Chloealtis conspersa*, male. Tegmen.

**C. conspersa** Harris. Plate VIII, 3.

Females dull yellow to dark brown. Pronotum with a more or less distinct blackish band along the upper margin. The first two or three abdominal segments with more or less black. Tegmina usually more or less sprinkled with dark dots. The males usually light brown above, with the lateral lobes of the pronotum always shiny black and the first abdominal segments with the sides black. The tegmina of females about one-half the length of the abdomen, while those of the male reach nearly to the tip. The inner wings much shorter. The hind femora of both sexes with two light spots on the outer face.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 20-28 | 10-12 | 7 -10 | 11.5-16 |
| Male | 15-18 | 10-11 | 7.7-12 | 10.7-13 |

Occurs along the edges of dry, open woods, and in neglected fence corners. Eggs are deposited in fence rails or dry sticks and logs.

### **Stenobothrus** Fischer.

Vertex obtusely triangular in female, acute in male. Foveolæ plainly seen from above as linear depressions. Median carina absent. Antennæ longer than head plus pronotum, nearly twice as long in the male. Median carina of pronotum cut somewhat behind the middle, the lateral carinæ incurved. Lateral lobes of the pronotum about as long as deep, nearly straight on front margin, sinuate on the back and lower margins. Tegmina variable, usually short in female and well developed in male. Wings slightly shorter than the tegmina. Hind femora rather slender, without cross-bars.

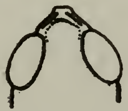

FIG. 24. *Stenobothrus curtipennis*, female. Head, from above.

**S. curtipennis** Harris. Short-winged Brown Locust. Plate VIII, 4.

The color and markings of this species are extremely variable. The dorsal surface of head, pronotum, and tegmina vary from light brown to fuscous. The face, cheeks, and sides of pronotum may be fuscous, green, or gray. Usually a dark fuscous band from the back of the eye along the upper border of the sides of the pronotum. The antennæ yellowish brown at base, dark brown or black towards the tips. The sides of the abdomen marked with black and the knees of the hind legs also black. The tegmina are extremely variable, and, while most of the individuals belong either to the short-winged or to the long-winged forms, no line can be drawn between them, as many examples are found varying from one form to the other. In the short-winged specimens the tegmina usually lack 3-5 mm. (females) or 2-3 mm. (males) of reaching the end of the hind femora. In the long-winged form they reach the end of the hind femora or pass it by 1-2 mm. The hind wings are always present, somewhat shorter than the tegmina, their usefulness depending upon their size. The males resemble those of *Chloealtis conspersa,* but are readily distinguished by the presence of the foveolæ (Fig. 24).

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 15 -24.5 | 6.5- 8 | 7 -16.5 | 11.5-14 |
| Male | 13.5-15.5 | 8.5-10.5 | 8.5-15 | 10.5-11.8 |

This species is often abundant in the tall grass of moist meadows, along ditches, or wherever the vegetation is thick and succulent. Morse states, " The season during which it may be procured in the adult state is the longest of all our locusts. I have captured specimens from June 24th to November 17th." We have taken it in various parts of the state from 11 July to 4 October.

### **Mecostethus** Fieber.

Head with the vertex horizontal, the median and lateral carinæ distinct, the latter straight. Apex truncate or broadly rounded. Lateral foveolæ small, triangular. Antennæ of male slightly exceeding the head plus the pronotum. Pronotum with the three carinæ distinct, the median carina prominent, cut somewhat in front of the middle. The disk rugose, with the posterior margin obtuse or rounded. The lateral lobes about as deep as long. Tegmina and wings well developed, usually surpassing the tip of the abdomen in both sexes. The intercalary vein elevated, and in the male furnished with a stridulating rasp. Hind femora rather slender, exceeding the tip of the abdomen in the male. Sub-anal plate of the male long, at least twice the length of its greatest depth. Valves of the ovipositor strongly protruding.

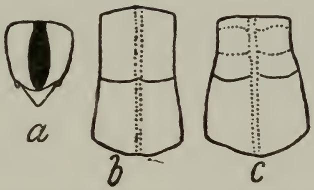

FIG. 25. *a. Mecostethus platypterus*, male. Ventral view of tip of abdomen.
*b. M. platypterus*, female. Disk of pronotum.
*c. M. lineatus*, female. Disk of pronotum.

### *Key to Species.*

Lateral carinæ of pronotum distinctly divergent behind. Prozona shorter than the metazona. Scapular area of tegmina with a pale basal streak. . . . . . . . . . . . . . . . . **lineatus**

Lateral carinæ of the pronotum nearly parallel. Prozona and metazona of about equal length. Scapular area of tegmina without a pale basal streak. . . . . . . . . . . . **platypterus**

**M. lineatus** Scudder.

General color yellowish to dark brown, the males usually the lighter. A narrow yellow line (more or less obscure in the female) extending from the upper border of the eye to the pronotum; below this is an indistinct dark band extending across the upper part of the lateral lobes of pronotum. The tegmina with a distinct yellow streak along the base of the discoidal area, extending from one-half to two-thirds their length. Hind femora with the outer face yellowish or reddish brown, darker below, with the lower face usually bright red, the apex black. Hind tibiæ yellowish with a pale ring towards the base; spines black. The tegmina of this species are narrower and of a more uniform color than in *platypterus*. The teeth of the rasp are low and dull. The under side of the ninth abdominal segment of the male has no mid-stripe of black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 34-38 | 10-11.5 | 26-31.5 | 18-21 |
| Male | 23-27 | 11-12 | 21-26.5 | 14.5-18 |

Morse states, " Though somewhat local, this species is rather common in southern New England in wet, sedgy meadows along rivers and brooks and in swampy tracts where water often stands on the ground for days at a time — may be looked for from the middle of July till the end of the season." North Haven, Thompson (A. P. M.); West Woodstock (W. B.); New Haven, 20 July (B. H. W.).

**M. platypterus.**

General color a darker brown than in *lineatus*. The dorsal margin of tegmina a grayish brown, with no yellow stripe along the scapular area. The ninth abdominal segment of the male has on the under (ventral) side a mid-stripe of black (Fig. 25a), which is not present in *lineatus.*

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| **Female** | 35-40 | 10-11 | 24-25 | 17.6-20.6 |
| **Male** | 23-26 | 11-12.5 | 19-21 | 15 -16.5 |

This species has been taken by Professor Morse at Thompson in company with *lineatus,* but is much less common, the female hard to flush and consequently difficult to secure.

### ŒDIPODINÆ.

Head with the vertex sloping downward, the face nearly vertical, rounded where joined to the vertex. Eyes rather small, shorter than the portion of the cheek below their orbits. Antennæ linear or sub-linear, situated above the middle of the eyes, sometimes almost above the eyes themselves. Disk of the pronotum with the rear margin much wider than the anterior margin. The lateral carinæ usually not distinct, the median carina wholly or at least partly crested, and cut by one or two sulci (except in *Arphia,* in which the median carina is entire). The tegmina and wings fully developed, usually bright-colored, and with a dark median band.

#### *Key to Genera.*

1. Median carina of pronotum in female always cut by one or more sulci. Tegmina with apical half membranous and regularly reticulate .......................... 2
   Median carina of pronotum not cut by principal sulcus (Fig. 26). Tegmina with apical half leathery and irregularly reticulate .................... **Arphia** p. 88

2. Median carina cut by only one sulcus............... 3

Median carina cut by two sulci, the front notch often less distinct than the posterior.................... 9

3. Disk of inner wing nearly transparent, not distinctly bounded by black border......................... 4

Disk of inner wing opaque, colored (red, orange, yellow, or black), bounded by black border except when disk is black .................................... 6

4. Pronotum with the disk flat, the dorsal front margin truncate. Hind femora with dusky cross-bars on outer face ..................................... 5

Pronotum with the disk roof-shaped, sides sloping downward, dorsal front margin angulate. Hind femora without dusky cross-bars on outer face..... **Chortophaga** p. 90

5. Frontal costa of male strongly sulcate the entire length. Median carina of pronotum prominent, higher on prozona than on metazona, distinctly cut by the principal sulcus ....................**Encoptolophus** p. 91

Frontal costa of male sulcate only just below the ocellus. Median carina of pronotum low, of equal height throughout, faintly cut by principal sulcus........ **Camnula** p. 92

6. Body slender, often compressed. Pronotum with the lateral carinæ extending only to the principal sulcus and cut by it.................................. 7

Body, especially of female, robust. Pronotum with the lateral carinæ extending in front of the principal sulcus and not cut by it (Fig. 28). Disk of pronotum often with numerous tubercles.........**Hippiscus** p. 93

7. Disk of wing yellow with dark median band......... 8

Disk of wing black with pale border (Plate IX, 1).... **Dissosteira** p. 96

8. Size medium; female usually over 30 mm., male over 26 mm. in length .................**Spharagemon** p. 97

Size smaller, female usually less than 30 mm., male less than 25 mm. in length ...............**Scirtetica** p. 101

9. Antennæ of male shorter than the hind femora, basal joints not strongly flattened. Frontal costa above the ocellus wider than the basal joints of antennæ.. 10

Antennæ of male longer than hind femora, the basal joints strongly flattened. Frontal costa narrowed towards apex, but at the widest point above the ocellus narrower than the basal joints of antennæ........ **Psinidia** p. 102

10. Hind tibiæ entirely pale. General color light brown or buff and white. Radial veins of wings not enlarged **Trimerotropis** p. 103

Hind tibiæ dusky towards base and at tip. General color dark gray or black. Wings with two or three radial veins distinctly enlarged (Fig. 34) ........ **Circotettix** p. 104

### Arphia Stål.

Vertex of the head triangular with the apex blunt or truncate, the disk with a distinct, usually deep, transverse curved depression back of the middle. Lateral carinæ distinct, the median carina broken by the depression. Foveolæ rather large but shallow. Frontal costa rather broad and sulcate around and below the ocellus. Pronotum with the medium carina compressed, high, and not notched by the principal sulcus. The front margin obtusely angulate and extended upon the posterior third of the occiput. Lateral edges of the disk rounded, lateral carinæ distinct only on the metazona. Sides of the pronotum not as long as deep. Tegmina leathery in texture, densely and irregularly reticulate. Inner wings (of our species) yellow at base. Hind femora stout, the basal half broadly flattened.

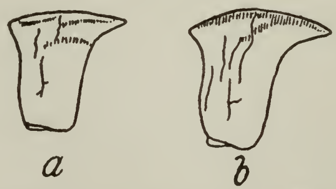

FIG. 26. *a. Arphia sulphurea*, male.
*b. Arphia xanthoptera*, male.
Lateral view of pronotum.

### *Key to Species.*

Frontal costa with the upper third narrowed, the sides approaching each other and meeting at connection with the vertex. Median carina of pronotum moderately elevated, but little arched. Hind margin of pronotum right-angled in male, slightly obtuse in female **sulphurea**

Frontal costa with the sides scarcely approaching each other, not meeting at the union with the vertex. Median carina high and arched. Hind margin of the pronotum acute-angled .................................. **xanthoptera**

**A. sulphurea** Fabricius. Sulphur-winged Locust.

General color yellowish brown to blackish brown in the males. Females usually somewhat lighter than the males. The tegmina in both more or less sprinkled with darker brown dots. The inner wings with the basal two-thirds a bright sulphur yellow; the outer third with a curved dusky band. Just back from the front margin of the wing and extending from the dusky band, is a streak of the same color, reaching nearly to the base of the wing, Fig. 27.* Hind femora with a pale ring near the apex, the inner surface with alternate bands of black and white, which are often faintly extended to the outer surface. Hind tibiæ nearly black or bluish black with a pale ring near the base.

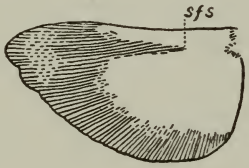

FIG. 27. *Arphia sulphurea*, male. Wing. *sfs*, sub-frontal shoot.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Females | 26-28 | 6-7.5 | 20.5-23 | 13.5-15.2 |
| Males | 17-19 | 6-7.5 | 17.5-20 | 11 -12.5 |

A very common species found in dry pastures. It commences to appear in early May and is most abundant through June and early July, though scattering specimens are found much later. The males, when disturbed, fly in short, zigzag flights, making a crackling noise.

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* This is sometimes called the sub-frontal shoot, and this term will be used when this character is referred to in following species.

**A. xanthoptera** Germar. Plate VIII, 5.

This species is somewhat larger than *sulphurea* and will be readily recognized by the characters given in the key. The front of the vertex is truncate; its lateral carinæ do not meet but are continuous with the sides of the frontal costa, which scarcely approach each other, and do not meet at the apex. The color varies from yellowish brown or bright reddish brown to nearly black. The tegmina, especially of the female, are sprinkled with dark. The disks of the wings are of a deeper yellow than in *sulphurea*. The sub-frontal shoot is about as long as the width of the band, and reaches less than half-way to the base of the wing.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 28-32 | 9-11.5 | 26.5-30 | 17 -18.5 |
| Male | 21-25 | 10-11 | 22.5-27 | 14.6-17.3 |

This species occurs in similar locations to, and with *sulphurea*, replacing it during the latter part of the season.

### **Chortophaga** Saussure.

Body rather slender, compressed, and punctate or finely wrinkled. Vertex triangular, the apex truncate. Median carina absent. Lateral carinæ rather faint. Lateral foveolæ triangular and very shallow. Frontal costa rather narrow, the lower part sulcate, the sides approaching each other slightly on the upper part and meeting those of the vertex. Antennæ rather short and flattened. Disk of pronotum roof-shaped, the front obtusely angled and produced forward slightly upon the occiput, the posterior margin acute-angled. Median carina prominent, slightly curved in profile, faintly cut a little before the middle. Lateral lobes of the pronotum deeper than long. Tegmina narrow, extending beyond the abdomen. Inner wings with the apical half somewhat smoky. Hind femora of medium size, surpassing the abdomen in male, usually slightly shorter than the abdomen in female.

**C. viridifasciata** DeGeer. Green-striped Locust. Plate VIII, 6.

This is the only species of our *Œdipodinæ* that is dimorphic in regard to color. Several forms have been described; but, as they grade into each other, only two forms are usually recognized, the green form, *virginiana*, and the brown form, *infuscata*. Many of the females can be referred to the green form while the majority of the males are brown. *Virginiana* usually has the head, pronotum, and outer face of hind femora bright green with a broad stripe of the same color along the basal two-thirds of the outer edge of the tegmina. The remainder of tegmina is light brown, and the abdomen reddish brown. In the brown form the tegmina are more or less mottled with light and dark brown. The inner wings of both forms are transparent, yellowish at the base, with the apical two-thirds smoky, becoming paler at apex; along the middle of the front margin is a dark bar. Hind tibiæ pale to dark brown, often with a pink, purple, or bluish cast, and with more or less distinct black bars on inner face which often show on the upper outer groove.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| **Female** | 22-32 | 6-8 | 18.6-25 | 13 -15.5 |
| **Male** | 17-20 | 6-8 | 16.8-20 | 10.5-12.5 |

This species passes the winter in the nymph stage and the adults appear during the last of April, being the earliest as well as one of the most common of our springtime locusts. It is scarce during August, but is found from September until frost. It occurs throughout the state.

### **Encoptolophus** Scudder.

Head somewhat swollen. Body a little shorter and stouter than in *Chortophaga*. Vertex broad, triangular, with the disk lower than the occiput. Median carina present but reaching only to the middle of the disk. Foveolæ long, triangular. Frontal costa narrow, deeply sulcate its entire length in the male, sulcate only above the ocellus in the female. Antennæ about as long as the head plus the pronotum in the female, somewhat longer in the male, moderately flattened apically. Pronotum with the disk flat, the front margin nearly truncate, the posterior margin right-angled. The median carina cut at the middle, the front half slightly higher. The sides deeper than long, compressed, and much wrinkled. Tegmina rather broad, equaling or slightly surpassing the abdomen in the female, always surpassing it in the male. The intercalary vein much nearer the ulnar vein than the median, and the discoidal area as wide as the widest part of ulnar area.

**E. sordidus** Burmeister. Clouded Locust.

Color rusty yellow or dark brown, mottled with darker or lighter shades of brown. In living specimens the disk of the pronotum often with a pinkish buff, X-shaped mark. Hind margin of pronotum often marked with dark velvety brown. Tegmina with two rather irregular, distinct pale bands. Inner wings transparent yellowish at base, the outer half smoky and becoming darker at apex. Hind femora with faint bands of pale and dark brown. Hind tibiæ with pale ring near the base.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 24-35 | 8-9 | 20.5-24 | 14-15.5 |
| Male | 19-21.5 | 8-9 | 16-19.5 | 11-12 |

This species appears about the first of August, and is very common in old pastures and fields throughout the state during the remainder of the season.

### **Camnula** Stål.

Size rather smaller than the average of the *Œdipodinæ*. Head compressed, vertex ovate in male, broader in female, with the front sloping downward. Median carina very faint, hardly showing in male. Foveolæ indistinct. Frontal costa not prominent, nearly flat, sulcate around the ocellus. Antennæ short and slender. Pronotum with the disk flat and smooth, truncate in front, obtusely angled behind. Median carina low, of equal height throughout, faintly cut in front of the middle. Sides of pronotum deeper than long. Tegmina narrow, reaching beyond the abdomen. Inner wings pellucid.

**C. pellucida** Scudder. Clear-winged Locust. Plate VIII, 7.

Light yellowish brown to fuscous. Antennæ pale at base, darker towards apex. A dark, somewhat triangular spot behind the eye, and a vertical elongated mark on and often nearly covering the front half of the lateral lobes of pronotum. Tegmina dark brown towards base, smoky towards apex, irregularly marked with patches of light and dark. The dorsal surface dark brown with a yellow stripe along each humeral angle. Inner wings transparent with the nervules dark. Hind femora yellowish with the apex fuscous and faintly marked with dark bars. Hind tibiæ yellowish brown, paler towards base.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 21-28 | 6-8.5 | 19 -23.5 | 11 -14.7 |
| Male | 17-21 | 7-9 | 15.5-18.5 | 9.5-12.3 |

Morse states: " In the markings of the tegmina, form, and color, *pellucida* looks like a diminutive *Hippiscus,* to which genus *Camnula* is not distantly related. It varies much in size and tegminal markings, but is not likely to be confused with any other species found here. It is extremely common, even abundant locally, throughout the northern part of New England, being probably the most numerous in point of individuals of any of our *Œdipodinæ.* It is found in dry grassy pastures and over other untilled lands, preferably on high ground. . . . It begins to appear in the winged state about July 1st and may be found during the rest of the season."

In Connecticut it occurs locally in the higher portions throughout the northern part. Thompson (" Not uncommon in a locality on north side of a high drumlin a mile east of village "), South Kent (A. P. M.) ; Colebrook, 21 July (H. L. V.).

### **Hippiscus** Saussure.

Our species of this genus rather large and robust. Head large with swollen cheeks. Disk of vertex sloping downward, broad, triangular, with apex obtusely rounded. Lateral carinæ not sharp. Median carina distinct at least on posterior half and extending back on the occiput. Foveolæ inconspicuous, usually triangular. Antennæ about the length of head. Pronotum slightly flattened apically; the disk flat, more or less roughened and with numerous blunt tubercles, truncate and somewhat constricted in front, usually right-angled or obtuse at posterior margin. Median carina distinct and cut by the principal sulcus. The lateral carinæ extending somewhat beyond the principal sulcus and not cut by it. Lateral lobes of pronotum constricted a little in front of the middle, about as long as deep. Tegmina extending considerably beyond the abdomen, especially in the male. Hind femora broad, flattened.

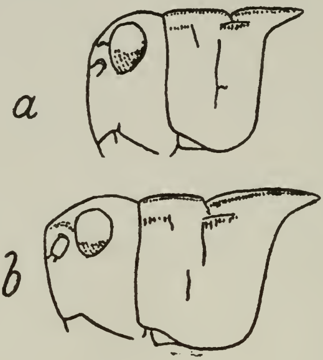

FIG. 28. *a. Hippiscus rugosus*, female.
*b. Hippiscus tuberculatus*, female.
Lateral view of head and pronotum.

*Key to species.*

Vertex much produced in front of eyes. Pronotum with the hind margin of vertex acutely angled. The prozona much shorter than the metazona. . . . . . . . . . . . . . **tuberculatus**

Vertex less produced in front of eyes. Pronotum with the hind margin of vertex obtuse (female) or right-angled (male). The prozona and metazona about equal in length **rugosus**

**H. tuberculatus** Palisot de Beauvois. Coral-winged Locust. Plate VIII, 8, 9.

Vertex considerably produced, sloping downward, and meeting the front at an angle (Fig. 28b). The lateral carinæ are distinct and are continuous with those of the frontal costa. Median carina distinct on occiput and extending to center of disk. Foveolæ very small, triangular. Pronotum with the disk granulated with small roundish tubercles. Hind femora very broad and flattened. General color ash-brown, darker above. Antennæ yellowish at base, darker towards the apex. Pronotum with a short longitudinal bar on the middle of the lateral lobes. Tegmina with fuscous and black patches. Humeral angle usually light brown. Wings generally bright coral red, rarely yellow, at base, bordered by a curved fuscous band with a sub-frontal shoot extending nearly to the base. The outer face of hind femora with faint blackish bars; the inner face black at base, with the apical half yellow and crossed by a narrow black band. Hind tibiæ yellowish to bright brown.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 36-44 | 11.5-13.5 | 30-32 | 18.5-20.5 |
| Male | 25-28 | 10.5-12 | 24-30 | 14 -16 |

This is our largest locust belonging to the *Œdipodinæ.* The males are ready fliers, taking to wing upon being approached. The female seldom flies up more than once and often escapes notice by remaining quiet. The species is found in dry, bushy pastures, on hillsides, or on light, uncultivated soils. The young appear about the first of September, and are "curious little depressed toadlike objects usually purplish leaden in color." This species reaches the adult stage the last of April or the first of May and is found until the latter part of July. Our earliest record is April 28. Thompson, South Kent (A. P. M.); New Haven, 4 May, 12 May, Oxford, 21 May, Rainbow, 24 May (W. E. B.); New Haven, 17 June (E. J. S. M.); Hamden 28 April, New Haven, 4 May, 14 June, Milldale, 21 May (B. H. W.).

**H. rugosus** Scudder.

This species is similar in size to *tuberculatus.* The vertex does not extend so far in front of the eyes and is more rounded at the connection with the face (Fig. 28a). The median carina extends to the front and a cross carina divides the disk into four nearly equal parts. Pronotum with the surface of the disk with numerous oblong or elongated tubercles, the hind margin obtusely angled. The disk of the hind wings usually pale yellow but varying to orange.

*H. rugosus* is very rare in New England and has not been recorded from Connecticut. It has been taken in Norway, Maine, and in Eastern Massachusetts. Scudder gives the distribution as "U. S. east of the Rocky Mountains." It should be looked for in localities similar to those inhabited by *tuberculatus.*

### **Dissosteira** Scudder.

Body slender, compressed, with the head rather prominent. Disk of vertex somewhat ovate, the front truncate. Lateral carinæ low; the median carina faint. Foveolæ small, triangular. Frontal costa sulcate, a little narrowed above and below the ocellus. Disk of pronotum with the front margin nearly truncate, the posterior angle obtuse. Median carina high, cut in front of the middle by a deep narrow notch, the posterior portion strongly arched. Lateral carinæ rounded, extending only to the principal sulcus. Lateral lobes of pronotum deeper than long. Tegmina broad, extending about a third of their length beyond the end of the abdomen. The intercalary vein prominent and about midway between the median and ulnar veins. Inner wings large, black, with a narrow yellowish border along the outer edge as far as the apex, which is fuscous. Hind femora rather stout, but small for the size of the species, shorter than the abdomen in both sexes.

**D. carolina** Linnæus. Carolina Locust. Plate IX, 1.

Color varying from light grayish yellow to dark fuscous. The tegmina usually thickly sprinkled with small dark dots, though specimens occur with the tegmina almost unspotted. Inner wings nearly black with the outer border pale greenish yellow, the apex smoky with several darker spots. Hind femora with the inner face whitish and crossed with three blackish bands, the first nearly covering the basal half. Hind tibiæ dirty yellow, usually with a whitish annulus near the base.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 33-42 | 11.5-13 | 36-43 | 15.5-20.5 |
| Male | 24-28 | 9.5-11 | 28-33.5 | 12.6-14.7 |

The Carolina locust is familiar to every one. It occurs along the roadside, in cultivated fields, and especially in places where there is more or less bare earth. It is a strong flier, and when alighting generally chooses a bare spot of ground with which the colors often harmonize so that it is very hard to detect. This locust is found throughout Connecticut; in fact, it is distributed all over the United States and Canada, except on the highest elevations. The adults appear about the first of July and are found until frost.

### **Spharagemon** Scudder.

Body slender, somewhat compressed. Head somewhat swollen dorsally. Vertex with the lateral carinæ converging more rapidly than in *Dissosteira*. Median carina faint or wanting. Lateral foveolæ more distinct than in *Dissosteira*. Frontal costa narrow, sulcate around and below the ocellus. Antennæ about as long as hind femora, slightly flattened towards the base. Pronotum with the disk much as in *Dissosteira*. The median carina prominent, usually high and deeply cut in front of the middle by a narrow notch. Tegmina considerably surpassing the abdomen in both sexes, the intercalary vein less prominent than in the previous genus and nearer the median than the ulnar vein. Inner wings with the base yellow, bordered by a dark median band. Hind femora rather stout, nearly reaching (female) or surpassing (male) the end of the abdomen. Hind tibiæ in our species with considerable red.

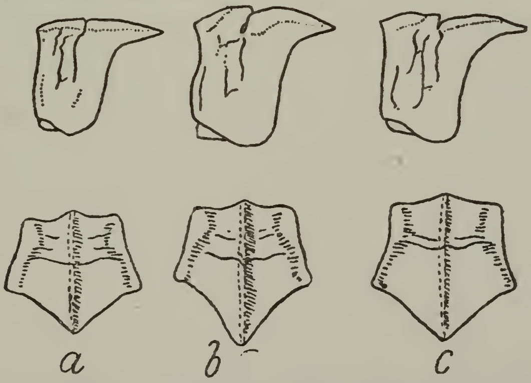

FIG. 29. *a. Spharagemon bolli*, female. *b. Spharagemon collare scudderi*, female. *c. Spharagemon saxatile*, female. Lateral view, and disk, of pronotum.

*Key to Species.*

1. Pronotum with the hind margin about right-angled. Notch in median carina vertical .................. 2

Pronotum with the hind margin acute-angled. Notch of median carina oblique, the sides often overlapping (Fig. 29b) ............................collare var.

2. Median carina rather high, the notch narrow, disk of prozona not elevated (Fig. 29a). Hind tibiæ with a pale ring followed by an equally wide dusky band **bolli**

Median carina lower, the notch deeper and more open, disk of prozona somewhat elevated (Fig. 29c). Hind tibiæ very rarely with a distinct dark band following the light basal ring............................**saxatile**

**S. collare** Scudder, vars. **scudderi** Morse, and **wyomingianum** Thomas.

These two forms of *collare* are readily distinguished from *bolli* and *saxatile* by the characters given in the key. The general color is pale yellow to pinkish brown in *wyomingianum,* often more rusty in *scudderi* and thickly sprinkled with dark brown or fuscous. The face is often ash-gray, the disk of the pronotum usually with an indistinct, pale, X-shaped mark. Tegmina with the dark markings arranged in more or less distinct bars. Hind femora grayish brown with traces of four dark bars on the outer face. Hind wings pale yellow with the median band nearly or quite reaching the anal angle. Sub-frontal shoot reaching one-third to one-half the distance to the base of the wing. Hind tibiæ coral-red, more or less sprinkled with dusky spots at base.

The typical *collare* is distributed throughout the central states but does not occur in Connecticut.

Morse points out the difference between *scudderi* and *wyomingianum* as follows: — "*Wyomingianum* may be readily distinguished from *scudderi* by its inferior size, the female of the former about equaling the male of the latter. In *wyomingianum* the head is less compressed, especially above; the eyes are much larger proportionally and are more prominent; and the antennæ are longer in proportion. The facial costa is rather more sulcate, especially in the male. The pronotum presents no distinctive characters, though in *wyomingianum* it is rather less compressed, and the posterior process rather more acute than in *scudderi*. In *wyomingianum* the hind femora are less distinctly fasciate externally, and internally show a decided difference; in *wyomingianum* the proximal fuscous band is obsolete ventrally, and the proximal two are not connected; while in *scudderi* the proximal band is complete, and the proximal two are broadly connected in tibial groove and on inner side, giving the appearance from below of a single, very broad fascia. In *wyomingianum* the hind tibiæ seem to be more often annulate with pale basally, and are less vivid in color. In *wyomingianum* the pubescence of the hind femora seems to be more highly developed than in *scudderi*, but individuals vary much. The color of the body as a whole is very similar, but *wyomingianum* has more of a yellowish cast, while in *scudderi* reddish or rusty predominates. This difference, however, is doubtless due merely to the character of its haunts."

**wyomingianum** Thomas.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 24-29 | 10 -13 | 23 -25.5 | 12.5-15 |
| Male | 18-20 | 9.5-12 | 18.5-20.5 | 11 -12 |

Occurs in dry, open, upland fields. Niantic, Thompson, North Windham, North Haven (A. P. M.); Scotland, 11 August (B. H. W.).

**scudderi** Morse.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 27-29 | 11 -11.5 | 25.5-28.5 | 14-16.5 |
| Male | 21-23 | 11.5-12.5 | 23 -24.5 | 13-14 |

This is a rather more southern form, and is often found locally common on light sandy soils and around sandy areas. Plainfield, 14 August, Scotland, 10 August (B. H. W.).

**S. bolli** Scudder. Boll's Locust. Plate IX, 2.

General color, yellowish to rusty brown in the female, the males being slightly darker, usually grayish to fuscous. Tegmina sprinkled with dark spots, which are grouped into three more or less distinct cross-bars, much more prominent in the males. Inner wings pale greenish at base, the median band broad, not reaching the anal angle of the wing. Sub-frontal shoot reaching about one-third the distance to the base. Apical portion of the wing transparent with the tip in the male often dark like the median band. The inner face of the hind femora yellow with three black bands; the outer face yellow, grayish, or rusty red with traces of the dark bands. Hind tibiæ dark at the base, the dark area bounded distally by a whitish ring, beyond which is a wide blackish band, fading into the red of the apical half. Apex fuscous.

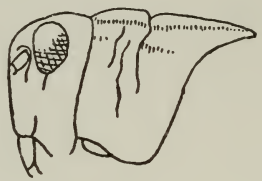

FIG. 30. *Spharagemon bolli.* Head and pronotum of female, from side.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 27.5-33 | 11-13 | 23 -28 | 12.5-17 |
| Male | 20.5-22 | 10-13 | 20.5-25 | 12.5-13.5 |

This is our most widely distributed species of the genus, occurring in dry fields and bush-covered areas throughout the state from July until late in October.

**S. saxatile** Morse.

Rather strikingly marked with brown to blackish fuscous spots or bands on an ash-gray ground. Abdomen more or less yellowish. Face often about equally sprinkled with ash-gray and brown. Antennæ fuscous, darker toward tips, the basal two-thirds with pale annulation. Disk of pronotum usually with faint, ashy colored, X-shaped mark. Tegmina brownish at base with three broad fuscous bands and the tip nearly transparent with numerous dark spots. Inner wings sulphur-yellow at base, the fuscous band broad, reaching to the anal angle, with a broad sub-frontal shoot extending about half-way to the base. Apical third of wing transparent, the tip more (male) or less (female) fuscous. Hind femora ash-gray on outer face with more or less distinct bands of fuscous dots; the inner surface yellow with four blackish bands. Hind tibiæ black at base, a pale ring beyond followed by coral-red. Spurs tipped with black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 28-34 | 12-14 | 25 -31 | 14 -17 |
| Male | 20-24 | 12-14.5 | 21.5-25.5 | 11.5-14 |

One of our prettiest species, its colors rsembling the lichen-covered rocks of the high, wooded ledges, where it is often abundant. It is a shy insect, quick to take wing, and considerable skill is required to capture it. Canaan, South Kent, Greenwich, New Haven, Deep River, Thompson (A. P. M.); Mt. Carmel, 6 August, Prospect, 15 August, West Rock, 6 October (W. E. B.); Scotland, 10 August, Lyme, 20 August (B. H. W.).

### Scirtetica Saussure.

Size small, head rather prominent. Eyes prominent, the occiput elevated. Vertex short, ovate, sloping downward in front. Lateral carina rather high, continuous with the frontal costa which is sulcate throughout, slightly constricted near apex. Lateral foveolæ short, triangular. Median carina faint. Pronotum compressed at the disk, flat, nearly truncate in front with the hind margin obtusely angled. Median carina low, cut a little in front of the middle by a narrow notch. The lateral lobes deeper than long. Tegmina extending considerably beyond the abdomen, contrastingly marked with large spots. Hind wings broad. Hind femora reaching nearly to end of abdomen (female) or surpassing it (male). Hind tibiæ ringed with white, dusky, and coral-red.

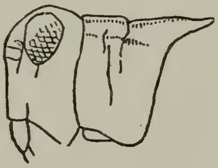

FIG. 31. *Scirtetica marmorata*, female. Head and pronotum, from side.

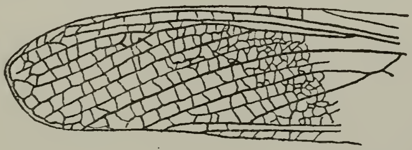

FIG. 32. *Scirtetica marmorata*, male. Distal part of wing.

S. marmorata Harris. Plate VIII, 10.

The color is extremely variable even in the same locality. The majority of our specimens are ash-color, more or less marked with fuscous to black. Some specimens occur in which the color is largely fuscous to black, sprinkled with white, yellowish, or reddish. A few specimens have been taken with the ground color pale green. The lower part of the face is usually ashy. Pronotum often with a pale X-shaped mark on disk. The tegmina marbled with grayish and dark blotches. Hind femora grayish, dark at apex and with three fuscous to blackish bands. Wings sulphur-yellow, with a dark, median curved band at base, the apex transparent, tipped with black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 22-25 | 9.5-10.5 | 20.5-22.5 | 10.5-12.5 |
| Male | 15-19 | 10.5-12.5 | 17 -20 | 9.3-10.7 |

This handsome locust will be recognized by the striking marbled markings of the tegmina. It has been taken in but one locality in Connecticut. It occurs in numbers along the sparsely clothed edges of the sand plains at North Haven.

### **Psinidia** Stål.

Head rather large, with the occiput much elevated. The vertex broad posteriorly, the lateral carinæ high, approaching each other rapidly, sloping downward, and continuous with the sides of the frontal costa. The frontal costa sulcate the entire length, very narrow towards the apex, gradually broadened below the ocellus. Antennæ long, the joints strongly flattened and three-sided towards the base. Pronotum much constricted at the middle, the front margin truncate, the hind margin slightly acute-angled. Median carina sharp, of even height throughout, cut twice in front of the middle. Lateral carina sharp and distinct on metazona. Sides of the pronotum deeper than long. Tegmina narrow, extending beyond the end of the abdomen in both sexes. Many of the cells in the middle third are two to four times as long as wide (Fig. 33). Towards the apex the maculations are confined to the marginal area. Inner wings with the disk yellow to orange, median band broad. Hind femora reaching nearly to the tip of the abdomen in the female, surpassing it in the male.

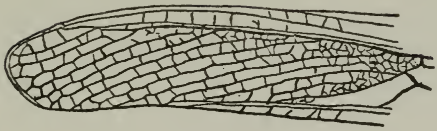

FIG. 33. *Psinidia fenestralis*, male. Distal part of wing.

**P. fenestralis** Serville. Long-horned Locust.

The general color of this species is influenced largely by the environment and varies from pale buff to reddish brown or even to black. Face and cheeks grayish or yellowish, the top of head and disk of pronotum darker. A narrow yellowish stripe extends back from the eye onto the disk of the pronotum, bordering the lateral carinæ. Tegmina yellowish to dark, the lower or outer half mottled with light and dark, the upper half unspotted. Wings with the basal third varying in different specimens from pale whitish yellow to orange or vermilion red, bordered with a broad black band reaching nearly to the base. Apex transparent. Hind tibiæ dirty gray or with bands of black and whitish.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 19-25 | 10 -12 | 17.5-24 | 11-13.5 |
| Male | 15-17.5 | 10.7-12.3 | 15.5-20 | 9-11.7 |

Inhabits sandy areas throughout the state. It occurs along the seashore, often in company with *Trimerotropis maritima.*

## Trimerotropis Stål.

Medium sized, body compressed, head wider than the prozona but less than the width of the metazona. Vertex longer than broad, narrowed gradually towards apex. The lateral carinæ continuous with those of the frontal costa. Median carina, if present, faint. Lateral foveolæ small, triangular. Frontal costa narrowed above and below the ocellus, and in our species sulcate at least on the lower two-thirds. Antennæ filiform. Pronotum with the disk flattened, often with small tubercles on the metazona, the front margin about truncate, and the rear margin with the angle acute to obtuse. Median carina low, cut in front of middle with two notches. Lateral carinæ rounded, indistinct.

Tegmina extending much beyond the abdomen in both sexes, nearly plain or sprinkled with dots. Inner wings with disk pale yellowish, a rather narrow dark band with the apical third transparent. Hind femora of moderate size.

**T. maritima** Harris. Plate IX, 3.

Size rather large. Pronotum with the median carina low. The lateral carina extremely variable. Metazona about twice the length of the prozona, the disk flat, often with numerous minute tubercles, the hind margin obtusely angled. The color varies from almost white to reddish brown mottled with fuscous blotches. Tegmina usually considerably mottled basally, rarely with traces of transverse bands. Hind wings with the disk very pale yellow with a narrow fuscous band, the width less than one-sixth the length of the wing. A sub-frontal shoot extending about half-way to the base. Apex of the wing transparent. Inner surface of hind femora pale, with traces of three dark bands; the outer surface not distinctly banded. Hind tibiæ yellowish, spines tipped with dark.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 28-35 | 11.5-14 | 29-35 | 14.5-16.8 |
| Male | 20-25 | 11 -13 | 23-27 | 11.5-14.5 |

Common along the sandy seashore of the state. Morse has taken this species at North Haven, and states that this is the only locality that he knows of where it is found away from the sound of the surf.

### **Circotettix** Scudder.

Body compressed. Eyes rather prominent. Vertex ovate, the lateral carinæ rather sharp, continuous with those of the frontal costa. Median carina very faint. Pronotum compressed in front of middle with the disk flat, the posterior margin about right-angled (female) to acute (male). Median carina low on the metazona, higher on the prozona, and cut twice before the middle. Lateral lobes of the pronotum much deeper than long. Lateral carinæ present on the metazona. Tegmina longer than the body, of equal width throughout. Hind wings with the radial area expanded, and with about three of the radial veins thickened. The disk yellow; a rather narrow, dark median band widening posteriorly, with a triangular sub-frontal shoot reaching about two-thirds the distance to the base of the wing. Hind femora small, not surpassing the end of the abdomen in either sex.

**C. verruculatus** Kirby. Plate VIII, 11.

Usually the darkest colored of our locusts. Ash-gray thickly mottled with brownish black; darkest on head and pronotum. Antennæ slender, annulated with white. Tegmina with the dark mottlings more or less arranged in cross bands, the venules on the lighter portions often white. Hind femora grayish with four dark cross bars, hind tibiæ grayish white with the apex dusky and a dusky band on the basal third.

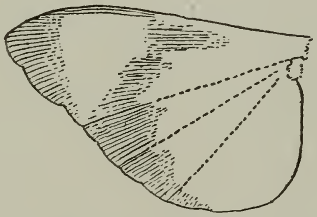

FIG. 34. *Circotettix verruculatus*, male. Wing.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 26-30 | 10-11.5 | 24 -28.5<br>(usually 27-28) | 13-14 |
| Male | 21-23 | 9-11.5 | 20.5-25<br>(usually 23-24) | 11-11.5 |

This handsome locust is found in the northern portion of the state on high elevations along bare ledges, where it delights to sun itself, its color harmonizing with the gray of the rocks and lichens. It is a shy insect and a ready flier. It may be readily recognized by its "song," which is louder than that of any other of our locusts, and is a series of sharp clicks or snaps instead of a continuous rattle. Canaan (A. P. M.); Colebrook, 21 July (H. L. V.).

## ACRIDINÆ.

The species of this sub-family occurring in Connecticut are readily distinguished by the presence of a distinct spine or tubercle on the prosternum between the legs of the front pair. The head is smaller and less swollen than in the two preceding sub-families, and the face (in our species) is nearly perpendicular. The disk of vertex is never depressed, the lateral carinæ are low, rounded, or often absent. Foveolæ often wanting or indistinct. The disk of pronotum without tubercles or wrinkles, the hind margin usually broadly rounded but never acute-angled. Median carina low, sub-equal throughout, lateral carinæ usually rounded or obsolete. Tegmina are present in our species, and, while usually well developed, are in a few species very short. The inner wings usually transparent, not bright colored. The prevailing color of most of the species of this sub-family is dull olivaceous brown, though some are mottled with delicate colors, yellow, green, reddish, or purple.

Among the *Acridinæ* are the most abundant and injurious insects of the whole order. Nearly all of the species pass the winter in the egg stage and begin to reach maturity in early June, though most species are not common until July. "The males of the *Acridinæ* rarely stridulate, and then only when at rest, by rubbing the inner surface over the outer surface of the tegmina."

### *Key to Genera.*

1. Size small, tegmina not over 25 mm. in length. Lobes of mesosternum transverse or equally long and broad. The inner margin usually rounded.............. 2

Size larger, tegmina 27 mm. or more in length. Lobes of mesosternum longer than broad, the inner margin straight ........................**Schistocerca** p. 107

2. Color usually dull, largely brownish or olivaceous. Vertex at its narrowest point between the eyes more than twice the width of the second antennal joint. Sub-genital plate of male without a sub-apical tubercle 3

General color when fresh bright pale green, with a conspicuous narrow purple mid-dorsal line generally on the head, extending across the pronotum and the dorsal part of the closed tegmina. Vertex at its narrowest point between the eyes less than one and one-half times the width of the second antennal joint. Sub-genital plate of male with a more or less distinct sub-apical tubercle ............... **Hesperotettix** p. 110

3. Dorsal surface of pronotum never twice as long as the average breadth, generally only one and one-half times the breadth, the sides more or less constricted at the middle. Antennæ of male less than twice the length of the pronotum. Sub-genital plate of male rounded apically ................... **Melanoplus** p. 111

Dorsal surface of pronotum twice as long as the average breadth, sides not constricted at middle. Antennæ of male at least twice the length of pronotum. Sub-genital plate with the apex truncate..... **Paroxya** p. 122

### **Schistocerca** Stål.

Size large. Vertex with the front sloping down. Lateral carinæ low, faint; median carina absent. Lateral foveolæ minute or absent. Face nearly vertical. Pronotum with the disk rounded on the prozona, nearly flat on the metazona, truncate in front, hind margin broadly rounded or in some males obtusely angled. Median carina present, but low. Mesosternal lobes longer than broad. Tegmina extending much beyond the abdomen. Hind wings large, nearly transparent. Hind femora slender, usually reaching to or surpassing end of abdomen. Last abdominal segment of male not swollen.

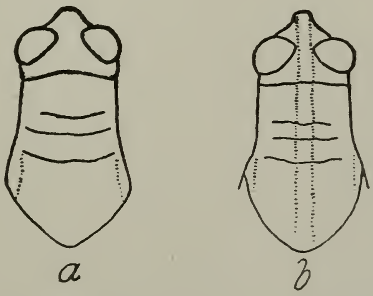

FIG. 35. *a. Schistocerca rubiginosa*, male. *b. Schistocerca alutacea*, male. Head and pronotum.

*Key to Species.*

1. Size very large. Tegmina 42 (male) to 55 (female) mm. .................................... **americana**
   Size smaller. Tegmina 27 (male) to 40 (female) mm. 2
2. General color yellowish brown to olive green, with a mid-dorsal stripe on head, pronotum, and closed tegmina. Vertex prominent ................. **alutacea**
   General color rusty brown, without mid-dorsal stripe as above. Vertex less prominent .......... **rubiginosa**

**S. americana** Drury. American Locust. Plate IX, 4.

This locust will be readily recognized by its size and conspicuous markings. The female is often two inches or more in length. Antennæ but little if any longer than the head plus pronotum. The color reddish brown, tinted slightly with vermilion. A broad median yellowish stripe extends along the head, pronotum, and closed tegmina as far as the end of the abdomen. A dark brown line from the eye extending down the cheek. Lateral lobes of pronotum with a wide yellow stripe on upper third and with a short narrow stripe below. Tegmina semi-transparent apically with numerous large brownish black spots. Lower margin yellowish at base. Wings transparent. Hind femora buff to brownish with one or two dark streaks along the upper third.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 48-55 | 13-15 | 50-55 | 28-30 |
| Male | 39-42 | 12 | 42-44 | 23-24 |

A female of *Americana* was taken at Hamden, 23 August 1909 (B. H. W.), in a dry field covered with blackberry vines and weeds. This is probably the first Connecticut record for this species. It is found occasionally in the vicinity of New York City, and it should be looked for in the southwest portion of the state from early May until the first of July, and from September to November.

**S. alutacea** Harris. Leather-colored Locust. Plate IX, 5.

Size rather large, the female much larger and more robust than the male. Vertex rather prominent, narrow; disk but little depressed (Fig. 35b). Antennæ about one and one-half times head plus pronotum. Median carina low but distinct. Tegmina surpassing the end of the abdomen about one-fourth their length. Hind femora slender, reaching the end of the abdomen (female) or slightly surpassing it (male). Color yellowish brown to a dirty olive green. A bright yellow mid-dorsal stripe on head, pronotum, and closed tegmina. Tegmina sometimes unspotted but usually with dusky blotches. Inner wings yellowish with darker veins. Hind femora yellowish, hind tibiæ olive green, spines yellowish tipped with black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 42-50 | 14.5-17.5 | 36-42 | 22.5-27 |
| Male | 28-32 | 15-17 | 24-30 | 17.5-19.5 |

Occurs on coarse grass and weeds in moist meadows and swamps. Deep River, North Haven, Stamford (A. P. M.); Scotland, 11 August, New Haven, 25 August to October (B. H. W.).

**S. rubiginosa** Harris-Scudder. Rusty Locust. Plate IX, 6. Size about the same as *alutacea.* Head and pronotum wider than in *alutacea,* vertex wider and less prominent (Fig. 35a). Antennæ of male about one and one-third times head plus pronotum (somewhat longer than in *alutacea*). Color uniform rusty brown to dirty gray. No median yellow stripe on head and pronotum. Tegmina usually with numerous dusky blotches. Wings transparent, glassy, yellowish, slightly rounded towards tips.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 39-54 | 14-16 | 32-41 | 20.5-24 |
| Male | 28-33 | 13-14.5 | 25-30 | 16 -19 |

This species is rather more widely distributed than *alutacea.* It prefers drier locations, and is found in bush-covered areas on light soil, dry pastures, along railroad embankments, etc. This species is considered synonymous with *alutacea* by Rehn,* but most specialists prefer to consider them distinct. Thompson,

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* Entomological News, XIII, p. 89, 1902.

Deep River, New Haven, North Haven, Stamford, Greenwich (A. P. M.); Westville, 7 August, 19 October, Granby, 7 October (W. E. B.); West Rock, 29 October (E. J. S. M.); Yalesville, 19 October (H. L. V.); Canterbury, Plainfield, 14 August (B. H. W.).

### **Hesperotettix** Scudder.

Size small, sides subparallel, but little compressed. Head small, vertex between the eyes very narrow with a slight central groove or depression. Face but little oblique, frontal costa narrow and sulcate throughout. Antennæ slightly (female) to considerably (male) longer than the head and the pronotum together. Pronotum long and rather narrow, the prozona about one and one-half times the length of the metazona. The sides of the disk sloping or rounded forming an angle with the lateral lobes. Median carina low, cut by single sulcus. Hind margin broadly rounded or very obtusely angled. Tegmina (in our species) much shorter than the abdomen. Fore and middle femora of male swollen, the hind femora extending much beyond the tip of the abdomen. Sub-genital plate of male with a more or less distinct tubercle near the apex.

**H. brevipennis** Thomas.

This is one of the most delicately colored of our locusts. General color a pale green. The pronotum with a conspicuous mid-dorsal purplish stripe which is often present on the head. The dorsal surface of the closed tegmina usually largely purple. Antennæ pinkish. Pronotum with a black bar on the upper third of the lateral lobes. Fore and middle femora and the upper face of the hind femora reddish. Outer face of the hind femora with more or less dark. Hind tibiæ pale green to bluish green; spines tipped with black. Tegmina not reaching tip of abdomen in either sex.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 20-24 | 6.3 -7.2 | 9.7-11.7 | 11.8-12.7 |
| Male | 15-17 | 7.25-8.5 | 7.6-10 | 9.5-10.5 |

This species has not yet been recorded from Connecticut, but has been taken in Massachusetts at Wellesley and Walpole, in New Jersey, and in Georgia. The season in which the adult appears is quite short; the Massachusetts specimens were taken between July 10th and August 30th. It occurs on thin gravelly soil sparsely covered with bunch-grass and running blackberry vines.

### **Melanoplus** Stål.

Body moderately stout, usually feebly compressed. Head not prominent. Face nearly vertical. Vertex between the eyes but little wider than the frontal costa, sloping downward in front, more or less sulcate, especially in the male. Frontal costa moderately prominent, usually sulcate below. Antennæ slender, less than twice the length of the pronotum. Pronotum with the disk generally about one and one-half times as long as broad, the front margin truncate and the posterior obtuse. The prozona slightly convex, the edges parallel, longer than the metazona, which is flat and more or less widened posteriorly. Lateral lobes nearly vertical, the upper half with a more or less distinct transverse dark band. Tegmina always present, in some species but little longer than the pronotum, oval or lanceolate, in others, reaching nearly to or surpassing the tips of the hind femora. Wings consisting of mere scales, or well developed, transparent, colorless. Hind femora moderately long and slender, reaching to the end of the obdomen in the female, surpassing it in the male. Cerci and furcula of male of variable form, furnishing characters much used in the identification of the species. The members of this genus cause much injury to agricultural crops. Fall plowing will destroy many of the egg-masses, one of which is shown in Fig. 36.

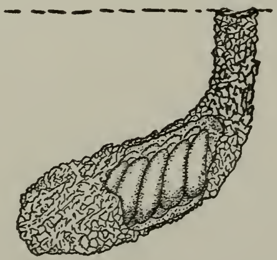

FIG. 36. Egg-mass of *Melanoplus* sp.

## *Key to Species.*

### *Males.*

1. Tegmina at most but little longer than the pronotum (Fig. 38) .................................... 2

Tegmina much longer than the pronotum .......... 3

2. Cerci slender, clasp-like, about four times as long as the breadth at middle (Fig. 38). Furcula well developed but short. Median carina of pronotum indistinct on the prozona ................................ **mancus**

Cerci broad, sub-triangular, less than three times as long as the breadth at middle (Fig. 38). Furcula usually very short. Median carina of pronotum distinct throughout ............................ **scudderi**

3. Cerci not broadened apically, of about uniform width or tapering towards the apex ...................... 4

Cerci irregular in shape, broadened apically or forked 6

4. Apex of sub-genital plate not notched. Cerci long, three or more times the breadth at middle.......... 5

Apex of sub-genital plate with a median notch. Cerci short, not longer than twice the breadth at middle, and nearly equal throughout (Fig. 40a) ............ **atlanis**

5. Furcula much longer than the last abdominal segment to which it is attached. Cerci tapering, the apical half less than one-half as broad as the extreme base (Fig. 42a) ........................ **femur-rubrum**

Furcula short, no longer than the last abdominal segment to which it is attached. Cerci nearly straight, and of nearly uniform width throughout (Fig. 44a) **fasciatus**

6. Cerci either distinctly forked or with a sub-median angulation ...................................... 7

Cerci with the apical half much enlarged, but not distinctly forked ................................ 8

7. Lower fork of cerci merely an angle or median process (Fig. 45a). Furcula consisting of slender spines..**minor**

Cerci distinctly forked, the lower branch narrower (Fig. 46a). Furcula consisting of short triangular lobes .......................................**luridus**

8. Cerci roughly sock-shaped (Fig. 47). Hind femora robust, not transversely dusky-banded. A large robust species with unspotted tegmina........**bivittatus**

Cerci terminating in a transverse, oval, tumid lobe (Fig. 48a). Hind femora slender, transversely banded. A medium-sized species with the tegmina more or less distinctly spotted..............**punctulatus**

*Females.**

1. Tegmina at most but little longer than pronotum (Fig. 38) ........................................ 2

Tegmina much longer than the pronotum........... 3

2. Interspace between mesosternal lobes usually distinctly transverse. Mid-carina usually obsolete or faint on prozona. Lateral lobes of pronotum considerably longer than deep — the lower half very pale, contrasting strongly with the dorsal half. Tegmina shorter than pronotum, sub-oval (Fig. 38).............**mancus**

Interspace quadrate. Median carina of pronotum conspicuous, equally developed throughout. Lateral lobes about as deep as long, their surface dark brown. Tegmina sub-lanceolate, tapering towards apex, about twice as long as wide (Fig. 38)...............**scudderi**

3. Large, robust; hind femora 16 mm. or over (usually 18-19). Dorsal area of closed tegmina separated from lateral area by a pale streak which sometimes suffuses entire dorsal area ..................**bivittatus**

Smaller species; hind femora not over 14 mm......... 4

4. Lower valves of ovipositor about straight, the lateral tooth nearly or quite obsolete (Fig. 48b). Interspace between mesosternal lobes transverse. Tegmina dusky-spotted. Hind femora conspicuously banded on outside and cherry-red within at base.....**punctulatus**

Lower valves of ovipositor with the apex more or less distinctly decurved and with a distinct lateral tooth midway of the lower outer margin................ 5

5. Interspace between mesosternal lobes longitudinal or quadrate (Fig. 43). Tegmina usually passing the

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* Copied from Morse.

hind femora, the body relatively slender. The pronotum when seen from sides often depressed at principal sulcus, with small, uninflated prozona..... 6

Interspace between mesosternal lobes sub-quadrate or distinctly transverse (Fig. 44b). Species with relatively stout bodies, swollen prozona, and tegmina not passing hind femora ............................ 7

6. Prosternal spine nearly cylindrical, the tip bluntly rounded, often bulbous (Fig. 41a). Cerci once and a half times or twice as long as wide, sharply pointed, somewhat acuminate, the sides slightly concave. Ovipositor seen from the side with the basal part of the scoop longer, the angle between the scoop and stem more obtuse (Fig. 42b). Hind tibiæ red. Hind femora largely or wholly lacking transverse dusky bands except on dorsal part of inner face. Mid-carina of pronotum frequently distinct on prozona **femur-rubrum**

Prosternal spine tapering, the tip pointed (Fig. 41b). Cerci shorter, only about one and one-third times as long as wide, rather dull at tip, the sides straight or often convex. Upper valves of ovipositor with scoop shorter, the angle at junction with stem more pronounced (Fig. 40b). Hind tibiæ either glaucous or red. Hind femora usually with conspicuous, dusky, oblique bands. Median carina of pronotum seldom distinct on prozona.........................**atlanis**

7. Tegmina about reaching end of hind femora. Interspace but little transverse ........................ 8

Tegmina reaching but one-half to two-thirds the length of the hind femora. *Interspace rather strongly transverse (Fig. 44b).* Very little angulation at junction of scoop and stem of ovipositor ...............**fasciatus**

8. Scoop of ovipositor very short, deeply concave, with a single denticulation or none at base of outer edge; lower valves with the tips correspondingly short and decurved (Fig. 45b). Hind tibiæ usually glaucous but often red. Tegmina flecked with dusky and pale spots, hind femora obliquely banded. Lateral carinæ of pronotum usually bordered below on the prozona

by a broad fuscous stripe which is crossed obliquely by a distinct, narrow, pale line. Prozona less inflated than in *luridus* and body less robust .............**minor**

Scoop rather long, the outer edge of basal half rather deeply notched, crenulate-denticulate, the tips of both pairs of valves long and evenly tapering (Fig. 46b). Hind tibiæ coral-red. Fuscous stripes on prozona indistinct, often lacking. Tegmina maculate and hind femora obliquely banded. A robust species, with noticeably tumid prozona and thick-necked aspect ...................................**luridus**

**M. mancus** Smith.

Size rather small. Eyes somewhat prominent, especially in the male. Tegmina shorter than the pronotum, sub-ovate, broadly rounded at the apex. Color dark fuscous above, lighter below. Lateral lobes of the pronotum crossed on the upper half with a distinct, broad, dark band. Pronotum with the lateral lobes contrastingly marked, pale below with a distinct broad dark band above, which is widened posteriorly. It is often lighter but never absent on the metazona. Hind femora without distinct cross bands. Hind tibiæ red, often pale towards base, the spines black, 10 or 11 in the outer row.

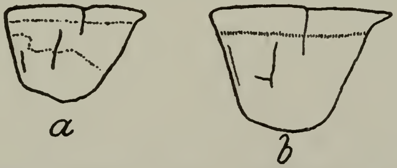

FIG. 37. *a. Melanoplus mancus*, female. *b. Melanoplus scudderi*, female. Lateral view of pronotum.

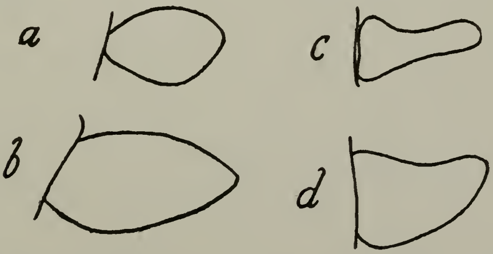

FIG. 38. *a. Melanoplus mancus*, female. *b. Melanoplus scudderi*, female. Tegmina. *c. Melanoplus mancus*, male. *d. Melanoplus scudderi*, male. Cerci.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 18-25 | 6.5-7 | 3-5 | 10-12 |
| Male | 14-17.5 | 6.5-7 | 2-4 | 8.3-9 |

This species is ordinarily rather common locally on some of the mountains of the northern New England states at altitudes of 2,000-3,500 feet. It has, however, been taken in Connecticut at North Madison and at Woodbridge, the latter part of August, by Professor W. S. Blatchley. At the former place he mentions it as being numerous on high ledges along the Hamanasset River.

**M. scudderi** Uhler. Scudder's Short-winged Locust. Plate IX, 7.

Size rather small. Tegmina about as long as pronotum, ovate-lanceolate in shape. Their inner edges just about touching in the male, slightly overlapping in the female. Wings less than half the length of the tegmina. Color dull reddish or wood-brown. The males and sometimes the females with an indistinct dusky bar reaching from the eye back along the upper half of pronotum to the metazona. Hind femora with two faint dark bars on their upper surface, the apex blackish. Hind tibiæ red, sometimes dull at base. Spines black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 17-24 | 6 -7 | 5-8 | 11-13 |
| Male | 15-18 | 6.5-7 | 4-5.5 | 10-11 |

This species is rather common the latter part of the season in open places in bushy pastures, on hillsides, or in open places along the edge of woodland. Morse found it "quite plentiful along the rocks and bushes on the talus slopes at the foot of West Rock, New Haven." The only species that *scudderi* will be mistaken for is *mancus,* which is apparently much more local and ordinarily frequents higher elevations. It will probably be often taken for a nymph of some other species of the genus. The nymphs, however, differ from the adults in having the wings and tegmina reversed, the wings appearing on the outside.

**M. atlanis** Riley. Lesser Migratory Locust. Plate X, 1.

Size medium. Vertex somewhat elevated above the pronotum. Median carina distinct only on the metazona. Tegmina surpassing the end of the hind femora. Color dark grayish or reddish brown. The dark band behind the eye is present on the prozona only, and is often more or less broken into spots, especially in the female. Tegmina distinctly spotted with fuscous along the discoidal area. Hind femora yellowish brown with two oblique dark bands on the upper and outer faces (more distinct than in *femur-rubrum*). Sides and under surface of abdomen yellowish (in *femur-rubrum* it is usually reddish brown).

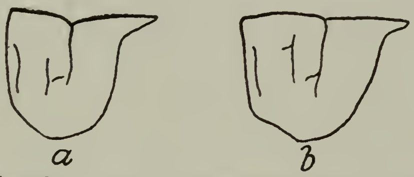

FIG. 39. *a. Melanoplus atlanis. b. Melanoplus luridus.* Lateral view of female pronotum.

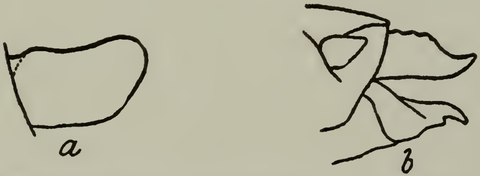

FIG. 40. *Melanoplus atlanis. a.* Cercus of male. *b.* Ovipositor of female.

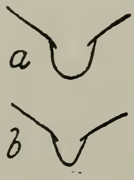

FIG. 41. *a. Melanoplus femur-rubrum. b. Melanoplus atlanis.* Prosternal spine of female.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 16-27 | 6.5-8 | 14.5-22 | 10-14 |
| Male | 17-21.5 | 7 -8.5 | 15 -21 | 10-13 |

"This species is found over the whole of New England from Nantucket to Canada, from the seashore to the alpine tops of the White Mountains." From various parts of the state, 18 July to 30 October.

**M. femur-rubrum** DeGeer. Red-legged Locust. Plate IX, 8.

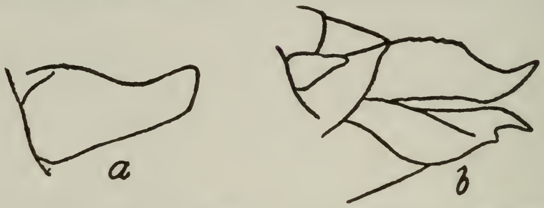

FIG. 42. *Melanoplus femur-rubrum*. *a*. Cercus of male. *b*. Ovipositor of female.

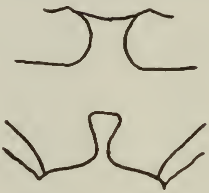

FIG. 43. *Melanoplus femur-rubrum*, female. Meso- and metasterna; interspace longitudinal.

Medium-sized. Pronotum with the median carina distinct on both the metazona and the prozona. Tegmina usually surpassing, at least slightly, the tips of hind femora; distinctly but very gradually tapering. Color reddish brown to dark olive brown. Occiput usually with a pair of widening fuscous stripes on its sides. Pronotum with the disk generally darker than the lower half of lateral lobes. The usual dark band on the upper part of the lateral lobes of the prozona, often inconspicuous in the female. The top of the occiput and disk of the pronotum often rose-red, and the lower part of the face and lower parts of lateral lobes yellowish green. Tegmina brownish fuscous, sometimes immaculate, but usually with fuscous dots along the basal half of the discoidal area. Hind femora reddish brown clouded with fuscous which often forms two oblique cross-bars on the upper face. Lower inner face dull yellowish or orange. Hind tibiæ almost always deep red, very rarely yellowish green. Spines black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 18-28 | 6.5-9 | 15.5-23 | 11 -15 |
| Male | 16-23 | 6.5-10 | 13 -20 | 10.7-13.3 |

This is our most common as well as our most injurious species of locusts, and is found all over the state from the last of July until after frost. It is especially abundant in moist meadows and places where the grass is thick and succulent.

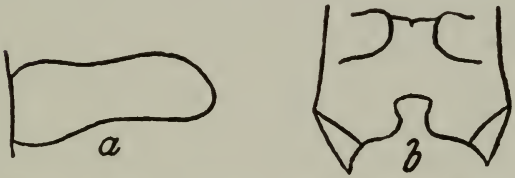

FIG. 44. *Melanoplus fasciatus*. *a*. Cercus of male. *b*. Meso- and metasterna of female; interspace transverse.

**M. fasciatus** Barnston-Walker.

Size medium, a rather thick-set species. Head with the vertex somewhat raised. Tegmina covering about one-half (female) or three-fourths (male) of the abdomen. Color variable, dark reddish brown to dark olivaceous gray. Yellowish below. A dark band from the back of the eye extending along the upper part of the lateral lobes of the pronotum to the metazona. Tegmina often with fuscous spots along the discoidal area. Hind femora brownish yellow, blackish at apex and base, and with two broad, oblique, blackish bars on the outer face. Pale or dull red on the inner faces. Hind tibiæ usually red, pale towards base, occasionally a smoky greenish color. Spines black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 16.5-25.5 | 6.5-8.5 | 9 -12 | 10.7-12.7 |
| Male | 16 -19 | 7.5-9 | 7.9-10 | 9.3-10.7 |

This species occurs in dry, uncultivated fields and pastures, especially among bush-covered areas. Thompson (A. P. M.); New Haven, 13 June — 23 August; Lyme, 21 August.

**M. minor** Scudder.

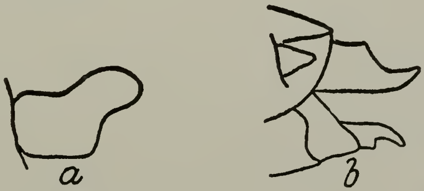

FIG. 45. *Melanoplus minor*. *a*. Cercus of male. *b*. Ovipositor of female.

Size medium. Eyes quite prominent and rather widely separated. Pronotum short. Tegmina reaching about to the tips of the hind femora, a little shorter in the female, sometimes slightly surpassing them in the male. Color dark brownish fuscous above, often tinged with reddish brown, yellowish below. The bar behind the eye shining black, and extending across the upper third of the lateral lobes of the prozona. Tegmina brownish fuscous, the discoidal area more or less distinctly marked with dark spots. Hind femora brownish yellow with indistinct, oblique, fuscous bars on the upper and outer faces. The lower face generally dull orange. Hind tibiæ variable, pale red, sometimes yellowish or lead-color.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 19-24 | 7 -8 | 13.5-18 | 12-13.5 |
| Male | 15-18-5 | 6.7-7.5 | 11 -15 | 10-11 |

This is the earliest species of *Melanoplus* to appear, reaching maturity early in June. Morse states that he has found it most numerous among sweet vernal and blue grasses (*Anthoxanthum odoratum,* and *Poa pratensis*) in pastures and mowing-lands on gravelly or sandy upland soils.

**M. luridus** Dodge. *M. collinus* Scudder.

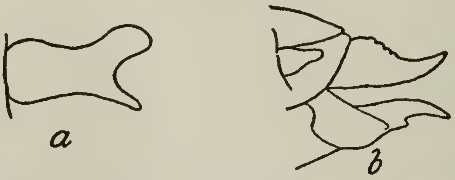

FIG. 46. *Melanoplus luridus.* *a.* Cercus of male. *b.* Ovipositor of female.

A medium-sized, robust species. Vertex distinctly elevated, somewhat swollen. Pronotum widened posteriorly with the disk nearly flat. Median carina distinct on the metazona only. Tegmina about reaching or slightly surpassing tips of hind femora. Color dark grayish brown to fuscous. Face dull bluish gray. Top of head and disk of pronotum fuscous. The black bar on upper half of lateral lobes of pronotum often faint, especially in the female. Tegmina usually sprinkled with fuscous. Hind femora brownish yellow with oblique bars of fuscous on the upper face; dull orange or yellow below; knees black. Hind tibiæ coral-red. Spines black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 19.5-27.5 | 7.5-9.5 | 14 -19 | 11.5-15 |
| Male | 16.5-20 | 7 -9 | 10.7-16.5 | 10 -12.5 |

Found on dry soils, especially near the edges of woodland. From various parts of the state from the 20th July throughout the season.

**M. bivittatus** Say. Yellow-striped Locust. Plate X, 2.

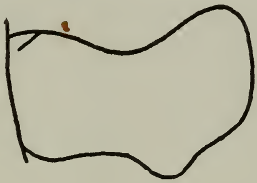

FIG. 47. *Melanoplus bivittatus.* Cercus of male.

Our largest species of *Melanoplus.* Median carina of pronotum low but distinct throughout. Tegmina reaching or surpassing the end of hind femora, often shorter in the female, tapering gradually. Hind femora rather long and somewhat stout. Color variable, olive brown to light greenish yellow above, yellowish beneath. A narrow yellowish stripe extends back from the upper angle of each eye along the lateral carinæ of pronotum nearly to the tips of the tegmina. Tegmina with scattering dots of fuscous along the anal angle, often unspotted. Hind femora dull yellow with more or less dark on the upper half of the outer face. The lower face yellow, the apex dusky. Hind tibiæ bright red to purplish. Spines black.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 29-40 | 9.6-14 | 19.5-26 | 15.5-22 |
| Male | 23-29 | 14 -16 | 16 -22 | 12.5-16.5 |

This is a common species occurring everywhere in New England. It is found from the latter part of June until the end of the season.

**M. punctulatus** Uhler. Grizzly Locust.

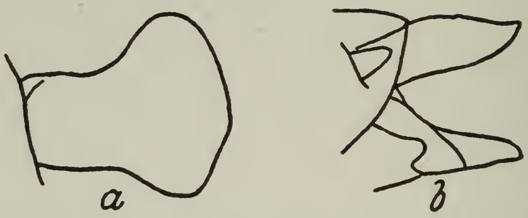

FIG. 48. *Melanoplus punctulatus*. *a*. Cercus of male. *b*. Ovipositor of female.

Size medium. Head prominent, vertex swollen and distinctly elevated above the pronotum. Median carina usually distinct throughout, but more prominent on the metazona. Tegmina slightly surpassing the hind femora in both sexes, tapering gradually, the apex rounded. Color dark gray mottled with blackish, clay-yellow beneath. Head and face often with a greenish cast. The black on upper part of the lateral lobes of pronotum broken and more or less indistinct. Tegmina thickly sprinkled and mottled. Hind femora yellowish banded with blackish. The lower face and basal third of inner face coral-red. Hind tibiæ red or gray, or a mixture of both. Spines black. A handsome species.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 23-29 | 10.5-12 | 14.5-21.6 | 11.3-12.7 |
| Male | 19-20.5 | 11 -13 | 14 -16.8 | 10 -11 |

This species usually occurs in the vicinity of pine trees, and is often found clinging to the trunks and branches. Canaan (A. P. M.); West Woodstock (W. B); New Canaan, 9 October (W. E. B.); Windsor, 13 September (B.H.W.).

### **Paroxya** Scudder.

Size medium. Body straight and nearly cylindrical. Head moderately large. Eyes large and prominent. Vertex narrow but wider than in *Hesperotettix*. Frontal costa prominent above the ocellus, punctate and but slightly sulcate. Antennæ long, usually more than one and one-half times the length of the head and pronotum together. Disk of pronotum about twice as long as the average width, the edges sub-parallel, at least in the male, and with the surface nearly flat. The prozona longer than the metazona, the latter with the hind border obtusely angled. Median carina low, but distinct and equal throughout. Lateral lobes vertical, longer than deep. Tegmina and wings variable, covering about three-fourths of the abdomen in our species. Hind femora moderately stout, tapering gradually and surpassing tip of the abdomen. Sub-genial plate of male short. Cerci long and incurved apically.

**P. floridana** Thomas. Plate X, 3.

General color olivaceous. Top of head, pronotum, and tegmina varying from light to dark brown. Face yellowish. Antennæ brownish, annulated with light. A dark brown bar from the posterior border of the eye extending back along the upper edge of the lateral lobes of the pronotum and often ending abruptly at the metazona; below this band often yellowish. Fore and middle legs and hind tibiæ often bluish green. Outer face of hind femora without transverse bands, brown-green or yellowish on lower face.

Measurements.

| | Body | Antennæ | Tegmina | Hind Femora |
|---|---|---|---|---|
| Female | 26-36 | 8.5-11 | 14.5-20 | 15.3-18.7 |
| Male | 20-25 | 13 -15 | 13 -16 | 12 -13.5 |

Rather common in the tall grasses and sedges along the edges of swamps and low lands. An active insect, but one which usually tries to escape attention by slipping around to the opposite side of the stem to which it clings. Morse has taken it as early as the 22d of July; our latest record is the 14th of October. Deep River, North Haven, Niantic, Stamford (A. P. M.); Branford, 3 September (H. L. V.); New Canaan, 21 September, New Haven, 25 August, Westville, 7 September, Wallingford, 14 October (B. H. W.).

## LOCUSTIDÆ.

The family *Locustidæ* includes the insects commonly known as katydids, green or long-horned grasshoppers, and camel-crickets. They are readily distinguished from the *Acrididæ* by the slender, many-jointed antennæ which are much longer than the body, the tarsi or feet which are four-jointed in the Connecticut *Locustidæ,* and the ovipositor which is sword-shaped. The ocelli are usually wanting.

The mouth-parts are well developed, with long, pointed mandibles. The stridulating or musical organ of the male is situated at the base of the tegmina. Each tegmen is furnished with a small transparent area, the upper one being crossed by a vein with minute, file-like teeth on the under side. The sound is made by rubbing these teeth on the upper side of the lower wing cover. Each species of *Locustidæ* has a distinct note by which it is possible to distinguish it, and many have two calls, one of which they use during the day and the other at night. The ear of the katydid, when present, is situated on the front leg near the basal end of the tibia, and consists of an oval cavity covered with a transparent membrane.

In the length of the antennæ, the structure of the organs of sound, and the auditory organs, the *Locustidæ* resemble the following family, *Gryllidæ;* but the former differ in having the sword-shaped ovipositor, and in the wing covers which slope obliquely downward at the sides, while in the *Gryllidæ* the wing covers are more flat dorsally, and are bent down over the sides of the abdomen at nearly right angles.

There are six sub-families of *Locustidæ* occurring in the United States, five of which are represented in Connecticut.

### *Key to Sub-families.*

1. Tegmina and wings present ...................... 2
   Tegmina and wings absent, or the former rudimentary 4
2. Prosternal spines present; vertex terminating in a sharp, flat spine, or produced upward and forward in a rounded tubercle or prominent cone; hind tibiæ without apical spines or with one on outer side only 3
   Prosternal spines absent; vertex rounded or deflexed, without spine, tubercle, or cone; tegmina always shorter than wings; hind tibiæ with an apical spine on each side .................... PHANEROPTERINÆ p. 125
3. Wing covers leaf-like, broadly expanded in the middle, concave within, longer than the wings; vertex terminating in a sharp, flat spine; pronotum crossed by two distinct transverse sulci........ PSEUDOPHYLLINÆ p. 131
   Wing covers narrow, expanding but little if any in the

middle, often shorter than the wings; vertex terminating in a rounded tubercle or prominent cone; pronotum without or with only one transverse sulcus. . CONOCEPHALINÆ p. 132

4. Pronotum extending back to the abdomen; prosternal spines present; fore tibiæ with a hearing organ near the base; tegmina rudimentary. . . . . . . DECTICINÆ p. 140

Pronotum short, not covering the whole top of thorax; prosternal spines absent; fore tibiæ without a hearing organ near the base. Wholly wingless. Eyes subrounded, situated partly above the basal joints of the antennæ; ovipositor nearly straight. . . . . . . . . . . . . . STENOPELMATINÆ p. 142

### PHANEROPTERINÆ.

This sub-family and the *Pseudophyllinæ* include the insects known as katydids, and here belong our largest species of *Locustidæ.* Head with apex obtuse or rounded, without cone or spine. Prosternum unarmed. The wing covers are of a bright green color and usually expanded in the middle. The wings are large and strong, and extend beyond the wing covers.

The katydids are the most arboreal of all the *Locustidæ,* are solitary in habit, and, while they may be quite numerous and do much injury to the leaves and twigs of shrubs and trees, are seldom noticed.

*Key to Genera.*

Tegmina of nearly equal breadth throughout, fastigium of vertex no broader than the first antennal joint. . . . . . **Scudderia** p. 125

Tegmina widened at the middle; fastigium of vertex much broader than the first antennal joint. . **Amblycorypha** p. 129

### **Scudderia** Stål.

The katydids of this genus are medium-sized. Head oval, with fastigium of vertex very narrow. Thorax longer than broad. Wing covers long and narrow, of nearly the same width throughout, and rounded at apex. The fore and middle femora unarmed beneath; hind femora long and slender. The short, broad ovipositor is curved sharply upward with the apical third finely crenulate on both margins. The males usually have the anal plates formed into long, curved processes which readily distinguish them from the other genera of this group. The process from the supra-anal plate curves downward and that from the sub-anal curves upward, and both of them are notched at the ends.

The species of *Scudderia* in general inhabit bushes, tall grass, and weeds, in meadows and along roadsides, especially in damp places.

### *Key to Species.*

1. Supra-anal plate of male with a long decurved process 2
   Supra-anal plate of male triangular, without a long decurved process (Fig. 53) .............. **septentrionalis**
2. Length of posterior femora 28 mm. or more......... 3
   Length of posterior femora less than 25 mm......... 4
3. Notch of supra-anal plate broad, with minute median tooth, the lateral processes slender, the notch as wide as the upturned sub-anal spine, the latter fitting into the notch when in natural position (Fig. 49) .... **texensis**
   Notch of supra-anal plate triangular, without a median tooth. Lateral processes broadly rounded. Sub-anal spine touching but not fitting into the notch (Fig. 50) **curvicauda**
4. Notch of supra-anal plate triangular, as in *curvicauda*. Width of tegmina much greater than depth of body (Fig. 51) ............................ **pistillata**
   Notch of supra-anal plate deep, rounded, forming a fork-shaped appendage with swollen lateral processes. Width of tegmina not greater than depth of body (Fig. 52) **furcata**

**S. texensis** Saussure-Pictet. Texas Katydid.

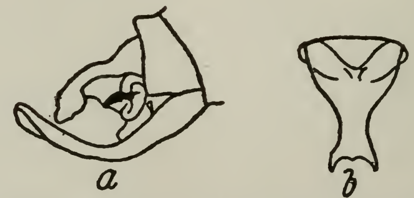

FIG. 49. *Scudderia texensis*. Tip of male abdomen. *a*. Lateral view. *b*. Dorsal view of anal segment.

General color bright green; body and face somewhat lighter. Pronotum much longer than broad, narrower in front than behind, with a yellowish line along the lateral carinæ. Posterior femora very slender, with three or four minute teeth on under side of inner carinæ. Male having notch of supra-anal plate broad, with a minute median tooth.

Measurements.

| | Body | Pronotum | Tegmina | | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| | | | Length | Width | | |
| Female | 24 | 6.5 | 34-37 | 8 | | 7 |
| Male | 20-24 | 6. | 33-36 | 7 | 26-30 | |

This species does not seem to be as common as *S. curvicauda* or *furcata* in Connecticut. It is said to be less arboreal than the other species. May be found clinging to tall grasses, weeds, and bushes, especially in damp places. East Hartford, 1 August, Westville, 9 August, New Haven, 21 August to 28 September, Plainfield, 14 September (B. H. W.).

**S. curvicauda** DeGeer. Curved-tail Katydid. Plate X, 4.

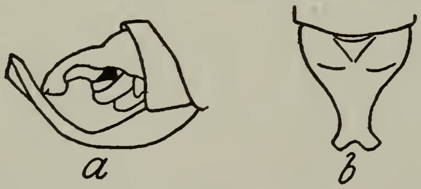

FIG. 50. *Scudderia curvicauda.* Tip of male abdomen. *a.* Lateral view. *b.* Dorsal view of anal segment.

About the same size and general color as *texensis,* though the yellow line on the lateral carinæ is usually absent. It is difficult to distinguish the female from that of *texensis,* but the female of *curvicauda* is usually more robust, with slightly wider wing covers and the ovipositor not as deeply notched. The male is readily distinguished by the notch of the supra-anal plate.

Measurements.

| | Body | Pronotum | Tegmina | | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| | | | Length | Width | | |
| Female | 22-24 | 6 | 34-38 | 8 | 27 | 7 |
| Male | 22 | 6 | 35-38 | 7 | 28-30 | |

This is one of our most common species. New Haven, August and September, Stafford, 24 August (W. E. B.); Scotland, Canterbury, Plainfield, 10-14 August (B. H. W.).

This species, together with *S. texensis,* causes considerable damage on the cranberry bogs in New Jersey. They destroy the berries by eating into them to get the seeds.

**S. pistillata** Bruner.

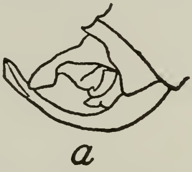

FIG. 51. *Scudderia pistillata.* Tip of male abdomen. *a.* Lateral view. *b.* Dorsal view of anal segment.

Species with shorter body and legs and broader wings than *curvicauda.* The notch of the supra-anal plate of the male resembles that of *curvicauda,* but the lateral processes are more triangular in shape.

Measurements.

| | Body | Pronotum | Tegmina Length | Tegmina Width | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 22 | 5.5 | 27.5 | 9 | 20 | 7 |
| Male | 18 | 5.5 | 33 | 9.5 | 22 | |

Salisbury, 30 August, Stafford, 24 August (W. E. B.).

**S. furcata** Bruner. Fork-tailed Katydid.

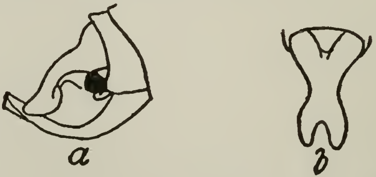

FIG. 52. *Scudderia furcata.* Tip of male abdomen. *a.* Lateral view. *b.* Dorsal view of anal segment.

Our smallest species. Wings narrow and of a dark green color. Lateral carinæ of pronotum more nearly parallel than in the preceding species. The notch of the supra-anal plate of the male is deep and rounded, the lateral processes much swollen.

Measurements.

| | Body | Pronotum | Tegmina Length | Tegmina Width | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 18-20 | 5 | 26-30 | 6 | 20-22 | 5 |
| Male | 16-18 | 5 | 28-30 | 6.5 | 21 | |

This is our most common species, occurring throughout the state.

**S. septentrionalis** Serville.

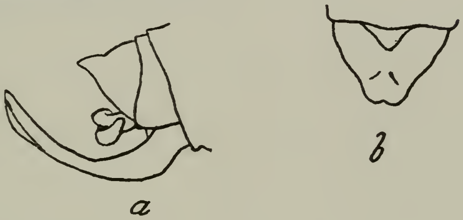

FIG. 53. *Scudderia septentrionalis.* Tip of male abdomen. *a*. Lateral view. *b*. Dorsal view of anal segment.

This species is about the size of *furcata.* Body short, eyes prominent. Pronotum narrower at anterior margin than at posterior. Wing covers rather wide, but not as wide as in *S. pistillata.* Female with the lateral lobes of pronotum broader than deep. Ovipositor long and curved but not sharply bent.

Measurements.

| | Body | Pronotum | Tegmina Length | Tegmina Width | Hind Femora |
|---|---|---|---|---|---|
| Male | 18 | 5 | 28 | 8 | 19 |

This species is quite rare. One specimen (a male) was taken in a tobacco-field, Southington, 4 August (B. H. W.).

## **Amblycorypha** Stål.

Head with the vertex flat and without spines; fastigium bent downward, much broader than the first antennal joint; eyes oblong oval. Antennæ long and slender excepting the two basal joints, the first being larger and thicker than the second. Pronotum much longer than broad. Wing covers broad, rounded at apex. Stridulating organ of male brown in color and crossed transversely by a prominent green vein. Male with supra-anal plate short, broad at base, narrowed at apex, and cut by a deep, triangular notch forming two slender, triangular appendages which terminate in short, spine-like processes. Female with broad, curved ovipositor, rounded at tip, with the apical half deeply serrated on both edges.

### *Key to Species.*

1. Tegmina 34-39 mm. in length, those of the male surpassing the tips of the hind femora.........**oblongifolia**
Tegmina less than 30 mm. in length, those of the male often reaching but not surpassing the tips of the hind femora ...................................**rotundifolia**

**A. oblongifolia** DeGeer. Oblong-leaf-winged Katydid. Plate X, 5.

A large species with bright pea-green wings, abdomen yellowish to brownish green. Stridulating organ brownish, usually with a green patch bordered posteriorly by the prominent green cross vein. Pronotum with anterior portion narrower than posterior, and the lateral carinæ prominent. Lower inner carinæ of posterior femora with six to twelve strong teeth.

Measurements.

| | Body | Tegmina | | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| | | Length | Width | | |
| Female | 23 | 38 | 11 | 30 | 11.5 |
| Male | 22 | 36 | 11.5 | 31 | |

Occurs throughout the state from August until October. Common on low trees and shrubbery, especially in damp places. Its note, which is often heard in late afternoon and during cloudy weather, has been likened to the sound made by drawing a fine-tooth comb over a taut string.

**A. rotundifolia** Scudder. Round-winged Katydid.

A smaller species, general color pale green, body somewhat lighter. Pronotum, especially in the female, with the anterior portion but little narrower than the posterior portion. Ovipositor more curved and more deeply serrated than in *oblongifolia.* Tegmina proportionately broader than in *oblongifolia.* Posterior femora with four or five teeth on the lower inner carina.

Measurements.

| | Body | Tegmina | | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| | | Length | Width | | |
| Female | 20 | 26-28 | 10 | 25 | 10 |
| Male | 19 | 26 | 9.5 | 24 | |

Less common than the preceding species. New Haven, 25 July to 26 September, Mt. Carmel, 25 September (W. E. B.); Scotland, 27 July, New Haven, 7 August, Lyme, 21 August (B. H. W.).

### PSEUDOPHYLLINÆ.

This sub-family is represented in Connecticut by only one genus containing one species.

### **Cyrtophyllus** Burmeister.

Head large and stout, with rather small roundish eyes; vertex compressed by the basal joints of the antennæ, and extending forward between the eyes, forming a small triangular spine, which is grooved above. Prosternum armed with two short spines. Pronotum nearly as wide dorsally as long, and cut by two transverse sulci; surface rugose, with the posterior portion raised above the rest of the pronotum. The tegmina extend beyond the wings and are nearly half as wide as long, obtusely rounded apically and concaved within. Sub-anal plate of male terminating in a long paddle-shaped appendage grooved on the upper side. Ovipositor of female broad, the apical half with minute teeth on the lower edge and curved upward. Apex with a rather sharp point. Stridulating organ prominent, of a brown color, with the central portion sunken and transparent.

**C. perspicillatus** Linnæus. True Katydid. Broad-winged Katydid. Plate VI, 4.

The true katydid is readily recognized by the broad wing covers, which when closed curve around the body, so that the edges touch above and beneath. The wing covers are dark green in color and thickly netted with prominent veins so that they much resemble leaves. The calling organ is large and well developed, which together with the peculiar shape of the wing covers enables the katydid to produce the loudest note of all our locustids.

Measurements.

| | Body | Tegmina | | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| | | Length | Width | | |
| Female | 28 | 34 | 16 | 20 | 14 |
| Male | 31 | 38 | 18 | 21 | |

This insect is common throughout the state, but is rarely seen, as it frequents the dense foliage of shade-trees and tall shrubbery. Occasionally it occurs locally in numbers. The writer was attracted to a colony of katydids one cloudy afternoon in a clump of trees near a small pond. Their call notes, which were almost continuous, were heard for quite a distance, and became very loud and discordant upon approach. West Woodstock, September (W. B.); New Haven, 9 August (P. L. Buttrick); New Canaan, 9 September, 5 October (B. H. W.); Mt. Carmel, 25 September, New Haven, 20 October (W. E. B.).

### CONOCEPHALINÆ.

Vertex of head projecting upward and forward in the form of a blunt, or sometimes a much prolonged, tubercle or cone. Prosternum toothed or with two slender spines. Apical spines absent on fore tibiæ. Front coxæ with a spine on the outside. Wing covers usually narrow, often shorter than the abdomen, and either green or brown in color. Calling organ of male well developed and with a prominent cross vein.

#### *Key to Genera.*

1. Fore and middle femora with spines beneath; vertex extending forward in the form of a long cone; calling organ of male opaque ........... **Conocephalus** p. 132
   Fore and middle femora without spines beneath; vertex ending in a round tubercle which is hollowed out at the sides; calling organ of male somewhat transparent ........................................ 2
2. Insects of small size; prosternal spine very short; ovipositor slender and nearly straight..... **Xiphidium** p. 136
   Insects of medium size; prosternal spines longer and more slender; ovipositor stout and usually upturned **Orchelimum** p. 138

### **Conocephalus** Thunberg.

Head with the vertex extended forward and upward between the eyes and terminating in a long cone which is armed beneath with a basal tooth. Face very oblique. Eyes rather prominent and nearly round. Prosternum with long slender spines. Disk of pronotum flat, narrower in front than at posterior margin. Lateral lobes curved obliquely backward in front and well rounded posteriorly. Wing covers long and narrow, slightly wider at the base, and rounded at the apex. Stridulating organ of male of same general color as the insect, opaque on the left wing cover, the central portion of the right wing cover transparent. Anal plates of male short, with the cerci swollen, incurved, and toothed.

### *Key to Species.*

1. Vertex with the cone slender, extending at least 3 mm. in front of the eyes.............................. 2
Vertex with the cone stouter, extending less than 3 mm. in front of the eyes.............................. 3
2. Lower face of cone with the apex black (Figs. 54, 55); a black line on either margin extending half-way to the base; inner lower carina of posterior femora with four or five minute spines......................**ensiger**
Lower face of cone wholly black from the apex to the basal tooth (Fig. 56); both lower carinæ of posterior femora with a number of rather prominent spines **exiliscanorus**
3. Cone of the vertex with the sides tapering; apex usually without black margins, rarely with a narrow black line (Fig. 57)..........................**robustus**
Cone of the vertex with the sides sub-parallel; the apex rounded and distinctly tipped with black (Figs. 58, 59)....................................**triops**

**C. ensiger** Harris. Sword-bearer. Plate X, 6.

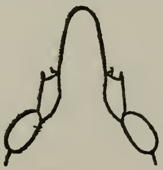

FIG. 54. *Conocephalus ensiger*, male. Dorsal view of vertex.

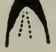

FIG. 55. *Conocephalus ensiger*, male. Under side of tip of cone

This is our most slender and graceful species. Wings usually bright green, head and body somewhat lighter, usually a yellowish line on the lateral carinæ of the pronotum. Posterior tibiæ and tip of ovipositor smoky brown. Cone of vertex long and slender, usually over 3 mm., rather acutely rounded at apex, a black line on either margin beneath extending from the apex halfway or more to the base. Tegmina long, narrower than in any of our other species. Brown examples of *ensiger* seem to be quite scarce.

Measurements.

| | Body | Cone | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 28-30 | 3.25-3.5 | 7-7.5 | 44-48 | 22 | 28-31 |
| Male | 24-26 | 3 | 7-7.5 | 37-40 | 20 | |

Occurs in moist fields and meadows where the grass is tall and coarse, from July to October. Scotland, 27 July to 7 August, New Haven, 11 August to 10 September (B. H. W.).

**C. exiliscanorus** Davis.

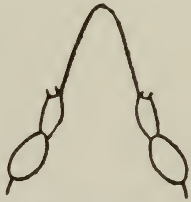

FIG. 56. *Conocephalus exiliscanorus*, male. Dorsal view of vertex.

Somewhat resembles *robustus*, but will be readily recognized by the long cone, the underside of which is black from the tip to the basal tooth.

Measurements.

| | Body | Cone | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 40 | 4 | 8 | 43 | 23 | 38 |
| Male | 34 | | | 39 | 23 | |

Beutenmüller states that this species is found from the latter part of July until cold weather in the salt marshes and meadows of Staten Island. A female in the collection of the Peabody Museum of Yale University, has the following record: New Haven (D. C. Eaton).

**C. robustus** Scudder. Plate X, 7.

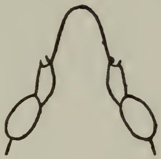

FIG. 57. *Conocephalus robustus*, male. Dorsal view of vertex.

General color pale green or pale brown, tegmina in the latter case usually sprinkled with small black dots. The cone of the vertex slightly shorter and blunter than in *ensiger*. The apex rarely tipped with black, the basal tooth small and blunt. A yellow line extends from the vertex along the lateral carinæ of the pronotum. Wings of the male as long as the tegmina, those of the female a trifle shorter.

Measurements.

| | Body | Cone | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 32 | 2.5 | 7.5 | 46-48 | 25 | 25-26 |
| Male | 30 | 2.25 | 8 | 40-44 | 22 | |

This is the most common species in the vicinity of New Haven. It is found on the salt marsh, along roadsides, and on dry, light soil, especially in the bunch-grass, in the roots of which it is said to deposit its eggs. Its song, which is very loud and much resembles that of the harvest-fly, *Cicada canicularis,* is frequently heard late in the afternoon and during the evening. New Haven, August and September, Scotland, 11 August, Plainfield, 14 August, North Haven, 17 September (B. H. W.).

**C. triops** Linnæus. Plate X, 8.

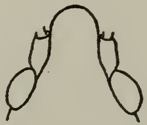

FIG. 58. *Conocephalus triops*, male. Dorsal view of vertex.

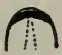

FIG. 59. *Conocephalus triops*, male. Under side of tip of cone.

Somewhat smaller than *robustus* and rather stouter than *ensiger*. The cone of the vertex is short, with the sides nearly parallel and the front obtusely rounded; the apex beneath distinctly tipped with black. Nearly half of the specimens taken are light brown.

Measurements.

| | Body | Cone | Pronotum | Tegmina | Hind Femora | Ovlpositor |
|---|---|---|---|---|---|---|
| Female | 27-30 | 2 | 6.5 | 30-39 | 20-22 | 28-34 |
| Male | 24-28 | 2 | 7 | 32-36 | 18-20 | |

This species was first taken near New Haven in 1902,* and that was the first record of the occurrence of a native specimen in New England. In 1904 it was fairly common in this vicinity, seven specimens being taken at one time in the tall grass along a ditch which contained water only in very wet seasons. New Haven, 29 August to 3 October, Westville, 19 September (B. H. W.).

### Xiphidium Serville.

The insects of this genus are our smallest winged locustids. Head with the face rounded, somewhat oblique, and with rather large roundish eyes. Vertex extends forward and slightly upward in the form of a rounded tubercle. Prosternal spines very short and weak. Tegmina narrow and straight, the length variable, but usually shorter than the abdomen. Wings usually not reaching the tips of the tegmina. Calling organs of male well developed, light brown in color, the middle transparent. Hind femora swollen at base, of medium length. Ovipositor slender, nearly straight, rarely slightly upcurved. Cerci of male swollen, with a basal tooth on the inner margin. The length of the wings and the color are quite variable in the members of this genus.

*Key to Species.*

1. Ovipositor shorter than the body.................. 2
   Ovipositor as long as the body................**ensiferum**
2. Body very slender, wings slightly exceeding the tegmina, which are fully developed and longer than the abdomen **fasciatum**

---

* *Psyche*, Vol. XI, p. 23, 1904.

Body stouter, wings usually shorter than the tegmina.
Tegmina usually not reaching tip of abdomen.... brevipenne

**X. fasciatum** DeGeer. Slender Meadow Grasshopper. Plate X, 9.

This pretty little species is one of our most slender-bodied locustids. The following parts are green: face, sides of pronotum, sides of abdomen, legs (excepting knees and tarsi), and base of ovipositor. A broad, dark, reddish brown, longitudinal stripe on occiput and pronotum. The tegmina, the abdomen above, and apical third of ovipositor reddish brown.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12-14.5 | 3 | 15-19.5 | 12.5 | 7.5-9 |
| Male | 12-13.5 | 3 | 13-18 | 12 | |

This grasshopper is very common throughout Connecticut in moist meadows from early July until late in the fall.

**X. brevipenne** Scudder. Short-winged Meadow Grasshopper.

Body rather shorter and stouter than in *fasciatum*. Posterior femora somewhat stout and rather short. The color is a light reddish brown, the face and sides of pronotum generally green. A broad, dark brown, longitudinal stripe bordered on either side with a line of yellow on occiput and disk of pronotum. The ovipositor wholly reddish brown, darker towards tip. Long-winged specimens occur rarely.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 11-13 | 3.5 | 7-8 | 11-12.5 | 10-12 |
| Male | 11 | 3 | 7-8 | 10-11 | |

This is also a very common species throughout the state, in damp fields, and plentiful on the salt marshes.

**X. ensiferum** Scudder.

"Very similar in general appearance to *X. brevipenne* Scudder, and may be only a large variety of that species. Typical examples are larger, with a longer ovipositor, which is equal in length to the body and equals or slightly exceeds the length of the hind femora. Tegmina of the common short-winged form covering about two-thirds of the abdomen in the female; usually reaching its tip in the male. Hind femora usually unarmed, though sometimes bearing one to four small teeth on their lower outer carina. Cerci of male rather stout, with the apical half curved slightly outward and depressed. Ovipositor slender, straight. The general color is more of a green than in *brevipenne;* the face, sides of pronotum and abdomen, and usually the four anterior femora being of that hue. The tegmina and wings are light reddish brown, as are also the tibiæ and ovipositor."*

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12-14 | 3.5 | 8.5 | 13.5 | 12-14 |
| Male | 12.5 | 3.5 | 10 | 13 | |
| Long-winged female | | | 14. | | |

North Madison, last week in August (W. S. B.).

### **Orchelimum** Serville.

Closely resembling *Xiphidium,* but of larger size. Spines of the prosternum cylindrical and slender. Wing covers narrow, often tapering towards the apex, surpassing the tip of the abdomen in our species. Wings extending beyond the tips of the tegmina. Calling organ similar but larger in proportion than in *Xiphidium.* Ovipositor stout, broad, and usually upcurved beyond the middle.

*Key to Species.*

1. Face without a brown median stripe.................. 2
   Face with a dark reddish brown stripe down the center **herbaceum**
2. Tegmina and wings of nearly equal length, extending but little beyond the tips of the hind femora; size medium (body 18-19 mm.).......................**vulgare**
   Tegmina shorter than the wings, distinctly surpassing the tips of the hind femora; size larger (body 22-23 mm.) ................................**glaberrimum**

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* Blatchley. "Orthoptera of Indiana," p. 375.

**O. vulgare** Harris. *O. agile* De Geer, of Scudder's catalogue. Common Meadow Grasshopper. Plate XI, 1..

General color grass-green or light reddish brown. Face pale green or light brown without fuscous stripe. A brown dorsal stripe which is narrow on the occiput and broadened on the disk of the pronotum. The male with two black dashes on either wing cover, which form the corners of a square area which encloses the calling organ. Legs light brown with the tarsi darker. The antennæ slender, about twice as long as the body. Pronotum long, with posterior margin well rounded. The tegmina are usually about as long as the wings and reach to or slightly surpass the tips of the hind femora.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 19 | 5.5 | 20 | 15-20 | 8-9 |
| Male | 18 | 5.5 | 20 | 13.5-17 | |

Very common throughout the state from the middle of July until fall. Frequents moist places where the grass and weeds are thick and succulent.

**O. herbaceum** Serville. *O. concinnum* Scudder.

Much more slender than *vulgare,* with narrow wing covers. General color grass-green. A broad, reddish brown longitudinal stripe on the pronotum and on the occiput, where it is narrowed to the width of the apex. This stripe is continuous down the face, extending broadly toward the clypeus. Legs green, with more or less brown. Wing covers extending beyond the tips of the hind femora, somewhat shorter than the wings in both sexes. Ovipositor slightly curved.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 18 | 4-4.5 | 20 | 13-16 | 8 |
| Male | 18 | 4-4.5 | 20 | 15 | |

Occurs on salt marshes from July until late fall.

**O. glaberrimum** Burmeister.

Similar to *vulgare* but larger, considered by some as a form of that species. In the female the brown stripe on the pronotum is more distinctly margined with black, and in the male the black dashes on the tegmina are larger. The tegmina of the male surpass the hind femora by about 4 mm., and the wings are about 4 mm. longer than the tegmina.

The measurements given by Blatchley are as follows: —

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 23 | 6.5 | 24-27 | 20 | 8.5 |
| Male | 22 | 6 | 26 | 19 | |

This insect should be looked for in locations similar to those frequented by the preceding species. We have no record of this species, but Scudder in his New England catalogue gives "Connecticut" as a locality in which it has been found.

### DECTICINÆ.

The members of this sub-family are wingless or with very rudimentary wings. The hearing organs are small and narrow, situated near the base of the fore tibiæ, the latter having an apical spine on their outer upper side.

"The tarsi are all more or less depressed, and their first two joints are sulcate lengthwise on the sides; while the first joint of those of the hind legs bears a free plantula (pad) beneath its base." — *Blatchley*.

This sub-family is well represented in the West, but in Connecticut we have but one genus with two species.

### **Atlanticus** Scudder.

Head with rounded face and small, nearly round eyes. Face broad; vertex extending between the antennæ in the form of a blunt, decurved ridge. Pronotum flattened on top, narrowed in front, and extending back over first abdominal segment; posterior margin well rounded, lateral lobes bent abruptly downward, lateral carinæ sharp. Tegmina of females rudimentary, wholly covered by the pronotum; those of the male about half as long as the body. Stridulating organ of male covered by pronotum. Wings very rudimentary or wanting. Posterior femora long and rather slender, passing the end of the abdomen in both sexes. Ovipositor stout at base, straight, about as long as the body.

The members of this genus are called "shield-back grasshoppers" on account of the large pronotum.

*Key to Species*

Pronotum more than half the length of the posterior femora, the front margin narrow, but little more than half as wide as hind margin........................**pachymerus**

Pronotum not more than half the length of the posterior femora, the front margin about three-fourths the width of the hind margin...........................**dorsalis**

**A. pachymerus** Burmeister. Plate XI, 2.

Grayish or reddish brown; the upper portion of lateral lobes of pronotum of the male black, often shining. Wing covers marked with black. A curved, yellow line above the posterior angle of the pronotum, which in the female is bordered above with black. Abdomen and femora sprinkled with minute black dots. The lateral carinæ of pronotum sharp and the posterior margin broadly rounded. The hind femora and ovipositor somewhat shorter than in *dorsalis*.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 20 | 9 | | 15 | 20 |
| Male | 19 | 9 | 8 | 15 | |

This insect is rare in Connecticcut. Occurs in dry localities. Scotland, 27 July, 2 September (B. H. W.).

**A. dorsalis** Burmeister.

The male is usually dark brown sprinkled with gray, female somewhat lighter. The pronotum is slightly longer than in *pachymerus*, the posterior margin more nearly truncate, and the lateral carinæ less sharp.

Measurements.

| | Body | Pronotum | Hind Femora | Ovipositor |
|---|---|---|---|---|
| Female | 24 | 9.5 | 20.5 | 23-30 |
| Male | 19 | 9 | 19 | |

This insect occurs in locations similar to those of the preceding species. We have no record of the occurrence of this insect in the state, but Scudder, in his list of the Orthoptera of New England, states that *dorsalis* has been reported from every New England state but Maine.

### STENOPELMATINÆ.

The insects belonging to this sub-family are commonly called "stone-" or "camel-crickets." One genus is represented in Connecticut.

### **Ceuthophilus** Scudder.

Wingless *Locustidæ,* medium or large in size, with a thick body. Head large, oval, deflexed, extending backward between the fore legs. Vertex without tubercles. Eyes somewhat pyriform in shape, widest at the top, and situated close to the base of the antennæ, which are long, slender, and cylindrical. Maxillary palpi long and slender, the first joint longest, grooved beneath at the apex. Pronotum short, prosternum unarmed. Hind femora stout, turned inward at the base, channeled beneath, with the margins of the channel either serrate or spined in the male, nearly smooth in the female. Ovipositor well developed, slightly upturned at the tip. Cerci of male long and slender, usually thickly clothed with hair. The members of this genus are nocturnal in habit, and are usually found in damp places under stones, bark of stumps, logs, and in damp, dark cellars. Uusually but one or two pairs are found together. Our collection contains very little material in this genus, and the following keys and descriptions are mainly taken from other papers. The females are very hard to identify, and the keys are for distinguishing the males. The female is similar in color to the male, and as the species are usually found in pairs, these should be placed together in the collection.

### *Key to Species.*

1. Large species; hind femora more than 20 mm. in length 2
   Smaller species; hind femora rarely more than 16 mm. in length .................................... 3
2. Hind femora less than four times as long as broad; hind tibiæ more than one-tenth as long as femora, more or less sinuate at base in old males......**gracilipes**
   Hind femora more than four times as long as broad; hind tibiæ scarcely more than one-tenth longer than femora, straight at base..........................**grandis**
3. Fore femora but little, if any, longer than the pronotum 4

Fore femora one-third or more longer than the pronotum .......................................... 5

4. General color clear reddish brown mottled with paler brown; hind femora of male more than twice as long as the fore femora; each of the lower carinæ with about 25 crowded minute teeth...............**terrestris**

General color dull sooty brown, with numerous paler spots; hind femora of male about twice as long as the fore femora, with 7 to 15 small but distinct teeth on each of the carinæ.........................**brevipes**

5. Hind tibiæ of male arcuate or sinuate in basal half; fore femora rarely exceeding the length of the pronotum.. **maculatus**

Hind tibiæ straight; fore femora somewhat longer than the pronotum .................................. 6

6. Hind femora stout, with 8 to 10 rather large unequal spines on the lower outer carinae...............**latens**

Hind femora rather slender, with 12 to 20 spines on the lower outer carinae well separated from each other ..................................**pallidipes**

Hind femora rather stout, with 25 to 30 minute spines on the lower outer carinae more or less crowded together ..................................**neglectus**

**C. gracilipes** Haldeman. Plate XI, 3.

Light yellowish to dark, heavily marked with irregular black blotches, the dark colors prevailing on the posterior half of all the segments. Outer sides of the hind femora with the black transverse bars more or less distinct. Antennæ long, three to four times the length of the body. Legs very long and slender. Fore femora more than half as long as the pronotum, the inner carina with two to three spines. Hind femora as long as, or longer than, the body, considerably more than twice the length of the fore femora, very stout at the base. Outer carina in male with about thirteen distinct, unequal, rather coarse spines. Hind tibiæ straight, or in old males slightly waved in the basal third; about a sixth longer than the hind femora. Cerci nearly a third as long as the hind femora. Ovipositor with the basal third stout, rather slender towards the tip; nearly three-fourths the length of the hind femora.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 23 | 6.75 | 10.6 | 22 | 25 | 15.5 |
| Male | 19 | 5.75 | 10 | 21.5 | 24.75 | |

Occurs during July and August, in dark damp cellars, under the bark of fallen trees, and in similar places. New Canaan, 15 September (B. H. W.).

**C. grandis** Scudder.

Color and markings similar to *gracilipes.* Legs very long and slender. Antennæ fully four times as long as the body. Fore femora about one and two-thirds the length of the pronotum, inner carina with three to four rather short, sub-equal spines. Hind femora as long as the body, very little more than twice the length of the fore femora, rather stout at base; the outer carina with eight to twelve distinct, nearly equal spines. Hind tibiæ straight in both sexes, fully one-tenth longer than the femora. Cerci slender and delicately tapering. Ovipositor more than half as long as the hind tibiæ, slender apically.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 23.5 | 6.7 | 10.75 | 23.4 | 25.6 | 13.5 |
| Male | 19 | 6.7 | 11.25 | 22.8 | 25 | |

Occurs in places similar to those frequented by *gracilipes.* Mt. Carmel, 6 August (E. F. Coe).

**C. terrestris** Scudder.

Reddish brown, the abdomen mottled with pale spots; often a median light stripe above on the pronotum, bordered by darker blotches; legs lighter; hind femora with the dark transverse bars not very prominent. Fore femora somewhat longer than the pronotum, unarmed. Hind femora rather stout, both carinæ of male with about twenty-five small tooth-like serrations; those of the female unarmed or with minute teeth on the apical third. Hind tibiæ straight, a little shorter than the hind femora. Ovipositor less than three-fifths the length of the hind femora, a little pointed and upturned at the tip.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 16 | 5 | 6.5 | 15 | 15 | 8 |
| Male | 13 | 5 | 6 | 16 | 15 | |

A female in our collection, labeled, "probably *terrestris,*" bears the data:— Salisbury, 27 August (W. E. B.).

**C. brevipes** Scudder.

Dull sooty brown, very freely mottled with dull yellow spots; thorax darker, usually with a narrow median stripe of clay-yellow. Body robust, fore femora one-third or more longer than the pronotum; a single spine on the lower outer carina. Hind femora short and stout, both carinæ in the male with seven to fifteen small, saw-like teeth on apical half; teeth smaller in female. Hind tibiæ straight, distinctly longer than hind femora. Ovipositor rather slender, about two-thirds the length of hind femora, the tip but little upturned.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 16 | 4.5 | 6.5 | 15 | 16 | 8 |
| Male | 13 | 5 | 6 | 14 | 15 | |

A record furnsihed by Professor Blatchley is as follows:— "North Madison, August (last week). Two taken from beneath stones."

**C. maculatus** Say. Spotted Camel Cricket.

Dark sooty brown above; thoracic segments often with a lighter brown median stripe; below, yellowish brown. The abdominal segments with small yellow spots above, arranged more or less in regular transverse rows. Legs reddish brown, hind femora with narrow dark brown cross-bars arranged in narrow rows. Fore femora slightly longer than the pronotum, the inner carina with one or two rather long sub-apical spines. Hind femora of male with the outer carina with twelve to fifteen unequal spines, the inner carina with a similar number of nearly equal minute spines. Hind tibiæ of male a little longer than hind femora, with the basal third bowed. Ovipositor about two-thirds the length of the hind femora, slightly tapering to the tip, which is upturned.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 16 | 5 | 6 | 16 | 17.25 | 10 |
| Male | 14 | 5 | 6 | 15 | 17 | |

This is our most common species, found in damp cellars, under stones, logs, etc. From various parts of the state, from June until December.

**C. latens** Scudder. Black-sided Camel Cricket.

Thorax with a median reddish brown stripe, on either side of which is a broad blackish stripe extending about half way down the sides, and back onto one or more segments of the abdomen. The sides below the dark bands are pale yellow. The abdomen and outer faces of hind femora spotted with brownish yellow. Legs light brown. Fore femora nearly a third longer than the pronotum. Hind femora stout with eight or nine spines on the outer carina, the four or five middle spines rather strong and prominent. Hind tibiæ straight, seldom longer than the hind femora. Ovipositor nearly twice as long as the fore femora, straight, with the tip a little upturned and acute.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 24 | 6.5 | 7 | 19 | 20 | 11 |
| Male | 22 | 6.5 | 7 | 19 | 21 | |

Under stones, Lyme, 21 August (B. H. W.).

**C. pallidipes** Walker.

Color and markings very similar to *latens*. This species is much smaller, however, the hind femora more slender, and differing greatly in the character of the spines. The ovipositor is stouter at the base than in *latens*.

Measurements.

| | Body | Pronotum | Fore Femora | Hind Femora | Hind Tibiæ | Ovipositor |
|---|---|---|---|---|---|---|
| Female | 14 | 4.3 | 5.8 | 14 | 14.8 | 9 |
| Male | 14 | 4.1 | 5.8 | 13.5 | 14.8 | |

One male, probably this species, taken at New Haven, 17 June (B. H. W.)

**C. neglectus** Scudder.

Chestnut brown more or less mixed with smoky; females usually darker. A broad, more or less indistinct and broken yellowish median stripe on pronotum. Sides of pronotum and abdomen more or less spotted with yellowish. Legs usually yellowish to chestnut brown, tips of all femora dark. Hind femora with scalariform fuscous markings. Antennæ slender, two to three times as long as the body. Legs rather slender and moderately short. Fore femora very little longer than the pronotum. Hind femora stout, about as long as the body and about two and one-fourth times as long as the fore femora. Outer carina minutely, closely, and uniformly serrate. Hind tibiæ slender, straight in both sexes, about as long as, or no longer than, the hind femora. Cerci moderately stout. Ovipositor half as long as hind tibiæ, straight, tapering in the basal half, the tip slightly upcurved and acutely pointed.

Measurements.

| | Body | Pronotum | Fore femora | Hind femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12.5 | 4.6 | 5 | 11.7 | 6 |
| Male | 12.5 | 4.4 | 5 | 12 | |

Lyme, 1 May (A. B. C.); Lyme, 21 August (B. H. W.).

## GRYLLIDÆ.

This family includes the crickets. The wing covers are flat on the dorsal part of the abdomen and bent abruptly down at the sides. The tarsi are three-jointed, without pads (pulvilli) between the claws; the fore coxæ longer than broad. The ocelli are usually present, and the antennæ, as in the *Locustidæ,* are long and slender. The hearing organ when present is also situated on the base of the fore tibiæ. The calling organ, as in the preceding family, is near the base of the tegmina of the males, but is larger, extending across both the anal and median areas of the tegmina. The chirp of the crickets, with which we are all familiar, is made only by the males, and is produced by rubbing the veins of the area of one tegmen over those of the other. The hind wings of the crickets are usually short and of but little use as organs of flight, though sometimes they extend nearly twice the length of the tegmina. The hind femora are well developed, and the insects of this family are ready leapers. The ovipositor of the female, when protruding, is usually long and cylindrical, with the tip often enlarged. The eggs of most species are deposited singly in the ground, while those that burrow in the ground deposit theirs in irregular masses in their burrows. The tree-crickets lay their eggs in single rows in the pith of the stems of various plants. See Fig. 60.

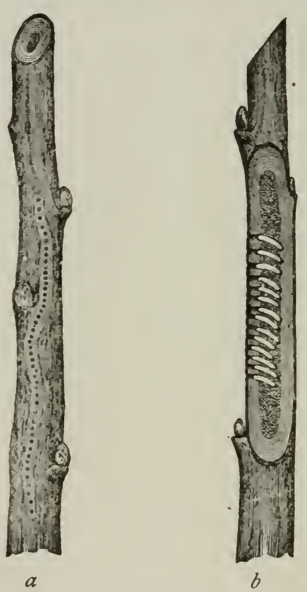

FIG. 60. Eggs of tree cricket in peach twig. *a*. Twig showing punctures. *b*. Twig cut to show the eggs.

*Key to Sub-families.*

1. Tarsi with the second joint minute, flattened laterally 2
   Tarsi with the second joint distinct, flattened vertically, heart-shaped .................... TRIGONIDIINÆ p. 161
2. Fore tibiæ not enlarged; female with the ovipositor extended ........................................ 3
   Fore tibiæ enlarged, fitted for digging; female without an extended ovipositor .......... GRYLLOTALPINÆ p. 149
3. Hind tibiæ rather stout, armed with two rows of stout spines, without teeth between them.... GRYLLINÆ p. 150
   Hind tibiæ slender, unarmed, or the spines slender with minute teeth between .............. ŒCANTHINÆ p. 155

### GRYLLOTALPINÆ.

The crickets of this sub-family have the fore legs modified so that they are fitted for digging, and burrow in the ground. The antennæ are much shorter and stouter than in our other *Gryllidæ*. The ovipositor of the female is not extended so as to be visible.

*Key to Genera.*

Body more than 25 mm. in length. Fore tibiæ broadly expanded and with prominent claws; hind femora slender; tarsi three-jointed ..................**Gryllotalpa** p. 149

Body less than 10 mm. in length. Fore tibiæ not broadly expanded, but with three or four spines at the apex, hind femora stout; tarsi with but one joint...**Tridactylus** p. 150

### Gryllotalpa Linnæus.

Head small; eyes about one-fourth as large as in other large-sized *Gryllidæ*. Pronotum large, the front emarginate, the posterior margin well rounded, the dorsal surface and sides convex, with the lateral carinæ absent. Abdomen rounded, about twice as long as pronotum. Fore legs modified for digging, very stout, broad, flattened, and furnished at apex with four claws. The upper two, which are the largest, are movable, while the others are fixed. Posterior femora but slightly enlarged, and shorter than the pronotum. Hind tarsi short. The ovipositor of the female is not visible, and the sexes are distinguished by the difference in the venation of the upper wing covers, due to the presence of the calling organ in the male. Cerci long and slender.

**G. borealis** Burmeister. *G. columbia* Scudder. Northern Mole-cricket. Plate XI, 4.

General color seal-brown, thickly covered with short, fine hairs, giving the insect a velvety appearance. The tegmina from about one-half to three-fourths the length of the abdomen. Wings dimorphic, slightly exceeding the tegmina in the short-winged form, or exceeding the tip of the abdomen in the long-winged form.

Measurements.

| Body | Pronotum | Tegmina | Hind Femora |
|---|---|---|---|
| 26-30 | 7-9.5 | 9-12 | 7.5 |

This insect will be readily recognized by its resemblance in miniature to a mole. It is found in the mud or sand along the margins of streams and ponds. Here it makes small burrows resembling those of a mole, about the size of a lead pencil. Not common. New Haven (shore of Lake Whitney), 4 August, Bloomfield, 18 October (W. E. B.).

### **Tridactylus** Oliver.

Head and pronotum rounded; eyes oval; antennæ short. The fore tibiæ not broadly expanded as in *Gryllotalpa,* but furnished with four apical spines or teeth. These teeth vary much in size and form. The tegmina are horny and opaque, not reaching the tip of the abdomen, and the males are not furnished with a calling organ. The hind wings are long and folded lengthwise like a fan. The posterior femora are long and broad, and, unlike the large mole-crickets, the members of this genus are active leapers. The species of this genus are "sand crickets," and are among the smallest crickets. The largest of the three species found in the United States is less than 10 mm. (about ⅜ of an inch) in length.

**T. terminalis** Uhler. Plate XI, 5.

General color glossy black, more or less marked with reddish brown spots. Posterior femora with two white spots or fasciæ. The wings reach to the tip of the abdomen or somewhat surpass it in both sexes.

Measurements.

| Body | Pronotum | Tegmina | Hind Femora |
|---|---|---|---|
| 6-8 | 2 | 3 | 3.5 |

This insect makes very small burrows in the sandy margins of ponds. We have not taken the sand cricket in this state, but Scudder states that it has been taken in Connecticut.

### GRYLLINÆ.

This sub-family includes the ground and field crickets which are everywhere so common during the summer and fall.

### *Key to Genera.*

Last joint of maxillary palpi twice the length of the one preceding; hind tibiæ with long, movable, pilose spines;

first joint of hind tarsi unarmed above or with one row of small teeth........................**Nemobius** p. 151

Last joint of maxillary palpi but little, if any, longer than the one preceding; hind tibiæ sulcate above, with a row of teeth on each side........................**Gryllus** p. 153

### **Nemobius** Serville.

Crickets of small size. Head and thorax of nearly equal width, clothed with rather long hairs. First, second, and fourth joints of maxillary palpus small, the third and fifth larger, the fifth or last joint about twice the length of the fourth and enlarged at the apex. Wing covers with the veins running lengthwise, while in the females of *Gryllus* the veins run obliquely from each side. Hind tibiæ with long unequal spines.

#### *Key to Species.*

1. Ovipositor shorter than hind femora, usually more or less curved .................................... **2**
   Ovipositor longer than hind femora, nearly straight.. **fasciatus**
2. Tegmina of male reaching tip of abdomen, yellowish brown in color. Length of body of female more than 8 mm. ................................**carolinus**
   Tegmina reaching only two-thirds to three-fourths the length of the abdomen, black or very dark brown in color. Length of body of female less than 6.5 mm. **palustris**

**N. fasciatus** DeGeer. The Striped Ground Cricket. Plate XI, 6 and 7.

The type form of this species is long-winged; the short-winged form, *vittatus,* is, however, much more common. The general color of the short-winged form is a dusky brown to a rusty black, the tegmina and legs sometimes paler. The head is marked with four black longitudinal stripes which are hardly discernible in the darker specimens. The long-winged form is usually nearly black, the head and pronotum clothed with long hairs. The tegmina of the male are as long, or nearly as long, as the abdomen, while those of the female cover about half the abdomen.

In the long-winged form the wings are more than twice the length of the tegmina.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 9.5-11 | 3 | 4 | 6.5 | 8-9 |
| Male | 10 | 3 | 5 | 6.5 | |

The wings in the long-winged form, 13 mm.

The short-winged form is very common throughout the state from early July until after frost. The long-winged form is quite rare.

**N. carolinus** Scudder. *N. affinis* Beutenmüller.

Head, antennæ, and pronotum varying from dull yellow to dusky brown; the latter more or less mottled with dark. Head and pronotum sparsely clothed with long, black, bristly hairs. Tegmina brownish yellow with a black bar on the upper third of the lateral field. The legs dull brownish yellow, often mottled with black. Tegmina of males as long as abdomen, those of the female covering about half of the abdomen. Wings absent. Cerci very slender and as long as the abdomen. Ovipositor moderately stout, shorter than the hind femora and slightly upcurved.

Measurements.

| | Body | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|
| Female | 8.5 | 3.5 | 6.2 | 3.8 |
| Male | 7 | 4.2 | 5.3 | |

Apparently not very common in Connecticut. Should be looked for on sunny slopes and in open woods. West Woodstock, September (W. B.); Lyme, 21 August (B. H. W.).

**N. palustris** Blatchley. Marsh Ground Cricket.

"Size, small; the body of male especially short and broad. Head tumid; eyes large, but not prominent. Pronotum one-third broader than long, the sides sub-equal, rather thickly beset with stiff, black bristles, as are also the forehead and dorsal surface of the two front femora. Head, tegmina, and body of most specimens a uniform dark piceous; disk of pronotum piceous, or fuscous sprinkled with piceous. Antennæ, legs, and ovipositor fuscous. Maxillary palpi yellowish, except the apical joint which is wholly piceous. Tegmina of female covering a little more than half the abdomen; those of the male hardly reaching its tip. Ovipositor about a third shorter than hind femora, distinctly though feebly arcuate, the apical blades but little enlarged at the base, very finely serrulate with dull, rasp-like teeth." — Blatchley.

Measurements.

| | Body | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|
| Female | 6.2 | 3 | 5 | 3.5 |
| Male | 5.8 | 4 | 4.5 | |

This small species inhabits swampy places, often living in sphagnum moss. Canaan, South Kent, August 18-19 (A. P. M.); Salisbury, 27 August (W. E. B.); Lyme, 21 August, New Haven, August and September (B. H. W.).

### **Gryllus** Linnæus.

This genus includes the large dark colored field crickets. The body stout, head large and globose; eyes large and rounded. Antennæ slender, longer than the body. Pronotum wider than long, the width about equalling that of the head. Hind femora stout; hind tibiæ with two rows of long fixed spines, their length increasing towards the apex. Ovipositor as long as or longer than the hind femora, the length varying but little in the same species. Some species are dimorphic as regards wing length.

### *Key to Species.*

1. General color black, tegmina often dull reddish brown; basal joint of antennæ not projecting beyond front of head .......................................... 2

Straw-colored, head and thorax marked with brown; basal joint of antennæ projecting slightly beyond front of head.............................**domesticus**

2. Ovipositor more than 18 mm. in length; about one and one-half times the length of the hind femora. Male stout, head large and broad................**abbreviatus**

Ovipositor not more than 14 mm. in length; about one and one-fourth times the length of the hind femora. Male more slender, head more narrow...**pennsylvanicus**

**G. abbreviatus** Serville. Common Field Cricket. Plate XI, 8.

Body large and wide. Head shining black, that of the male much swollen and broader than the pronotum, less prominent in the female. Pronotum about one and one-half times as wide as long. Tegmina usually dark reddish brown to black, sometimes dull yellowish brown, covering the abdomen in the male or about three-fourths of the abdomen in the female. Wings much shorter than the tegmina in the type, or twice their length in the long-winged form, *luctuosus*. Hind femora very stout, dark reddish brown to black. Ovipositor very long, equaling or exceeding the body in length, and nearly or fully one and one-half times the length of the hind femora.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 18-22 | 4.75 | 12 | 13 | 18-20 |
| Male | 18-21 | 4 | 12 | 13 | |

Common throughout the state from August until frost.

**G. pennsylvanicus** Burmeister.

A rather broad species with the head of the male less swollen than in *abbreviatus;* pronotum slightly wider in proportion than in the above species. The tegmina vary in color from deep black to grayish brown, often with a yellowish brown line along the humeral angle; the tegmina reach the tip of the abdomen in the male, nearly to the tip in the short-winged female, or slightly surpass it in the long-winged form. Hind femora short and stout. Ovipositor always shorter than the body, slightly longer than the hind femora.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 22 | 4 | 9 | 12 | 14 |
| Male | 16-17 | 3.5 | 10 | 12 | |

Common throughout the state from May until frost; is found under stones and rubbish.

**G. domesticus** Linnæus. House Cricket.

Pale yellowish brown or straw-color, with reddish brown markings on head and pronotum. Tegmina reaching nearly or quite to the tip of the abdomen, sometimes a reddish brown spot on their basal third. Inner wings either abbreviated or extending considerably beyond the ends of tegmina. Hind femora short and slender. Ovipositor about one and one-fifth times the length of the hind femora, pale brown becoming darker towards the tip.

Measurements.

| | Body | Tegmina | Pronotum | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 15 | 11 | 3.5 | 10 | 12 |
| Male | 16.5 | 11 | 3.5 | 10 | |

This cricket is very numerous in Europe and is the " cricket on the hearth." It is very rare in this section, though it has been taken in the vicinity of New York. It is probably less common now than it was when the old-fashioned stone fireplaces were used. We have no records of the capture of this species in Connecticut.

### ŒCANTHINÆ.

This sub-family contains the small whitish insects known as tree crickets. Two genera are represented in Connecticut.

### *Key to Genera.*

Hind tibiæ armed with weak spines; first joint of antennæ without spine on under side; hind wings at most but little longer than the tegmina................**Œcanthus** p. 155

Hind tibiæ not armed with spines; first joint of antennæ with a blunt tooth on the under side; hind wings nearly twice as long as the tegmina.....................**Xabea** p. 161

### **Œcanthus** Serville.

Head and thorax elongated; the latter with deflexed sides and the anterior portion of pronotum somewhat narrower than the posterior. Wing covers of the female regularly reticulate, with the oblique longitudinal veins plainly visible; wing covers bent around the body, while the male is given a much broader appearance by having the wing covers flattened; they are also more transparent and of a firmer texture than those of the female. Hind femora slender; tibiæ armed with weak spines between which are minute teeth; tarsi four-jointed, long and slender, with the second joint very small and compressed. Ovipositor shorter than hind femora, straight, with the apex slightly enlarged and rather blunt.

This genus includes the small greenish white insects known as tree crickets. These may be seen throughout the latter part of the season clinging to tall weeds and shrubs, or on the trunks and large branches of trees. The eggs of the tree crickets are deposited in the tender shoots or pith of various plants. See Fig. 60. Raspberries and blackberries are often seriously injured by at least one species, whose punctures so weaken the canes that they readily break off.

*Key to Species.*

1. Antennæ with one or more black marks on the under side of each of the first two basal joints. Tegmina of male narrow, the width less than half the length.... 2
   Antennæ without black marks on the under side of the first two basal joints. Tegmina of male broad, the width more than half the length..............**latipennis**
2. The two basal antennal joints each with one mark.... 3
   Antennæ either black or with two marks on each of the two basal joints.......................... .. 5
3. Antennal marks elongated, of unequal size............ 4
   Antennal marks consisting of small oval dots (Fig. 61) **niveus**
4. First antennal mark long and straight, second mark oblong (Fig. 63).......................**exclamationis**
   First antennal mark long and hooked at base; second joint with oblong mark (Fig. 62).........**angustipennis**
5. Head and thorax greenish yellow or yellowish brown; antennal marks distinct......................... 6
   Head and thorax black or striped with black; antennæ usually black, but, when marks are discernible, those of first joint generally connected at apex (Fig. 64) **fasciatus**
6. Pale greenish or yellow; antennal marks distinct, parallel; outer mark on first joint nearly round (Fig. 65) **quadripunctatus**
   Head, thorax, and legs testaceous; outer mark on first joint elongated and oblique (Fig. 66)..............**pini**

**Œ. latipennis** Riley. Broad-winged Tree Cricket.

Male, greenish white; female yellowish green. Antennæ without black markings on the basal joints. These joints and top of head are of a distinct pink color. The wing covers of the male are much wider than in any of our other species. Blatchley gives the following: —

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12.5 | 3.1 | 14.5 | 10 | 6.5 |
| Male | 12.5 | 3.1 | 15 | 10 | |

Width of dorsal surface tegmina of male, 7.5 mm.

This insect is said to live on low plants in damp places. Should be looked for during September and October. We have no record of this species being taken in the state.

**Œ. niveus** DeGeer. Snowy Tree Cricket.

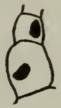

FIG. 61. *Œcanthus niveus* Basal joints of antenna, showing markings.

General color greenish ivory-white. The under side of the two basal joints of the antennæ each with a small, roundish, black spot. Head larger and pronotum wider anteriorly than in *angustipennis*. The maxillary palpi are longer than in the other species. The tegmina are much longer than the abdomen, and the wings equal to, or slightly longer than, the tegmina. Ovipositor short, straight, and usually tipped with black.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 14 | 2.25 | 14 | 11 | 5.5 |
| Male | 12 | 2.25 | 12 | 10 | |

Much has been written in the past regarding this species and the injury caused by it. From careful observation it is thought that in much of this literature other species have been confounded with this one. From our experience *niveus* is much less common than at least three of our other species. New Haven, 16 August (P. L. B.); Norwalk, 13 October (W. E. B.); New Haven, 12 October, Windsor, 13 September (B. H. W.).

**Œ. angustipennis** Fitch. Narrow-winged Tree Cricket. Plate XI, 9 and 10.

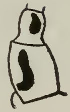

FIG. 62. *Œcanthus angustipennis.* Basal joints of antenna, showing markings.

Pale yellowish green, top of head and thorax sometimes yellowish brown. The basal antennal joint with an elongated black mark curved inward at the base, second joint with an oblong black mark. Head small, anterior portion of pronotum narrow. Tegmina narrower than in any other species excepting *quadripunctatus.*

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12 | 2.5 | 12 | 9 | 5 |
| Male | 12 | 2.5 | 11.5 | 9 | |

This species is quite common around New Haven. Often seen resting on the trunks of trees. New Haven, 14 August to 12 October, Hartford, 22 September, New Canaan, 19 September to 20 October (W. E. B.).

**Œ. exclamationis** Davis.

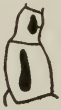

FIG. 63. *Œcanthus exclamationis.* Basal joints of antenna, showing markings.

Closely related to *Œ. angustipennis,* but is larger, and the top of pronotum is not clouded, as is often the case in the latter species. The general color is pale greenish white, and the black markings on the antennæ resemble an exclamation point. The long mark on the first joint is not bent at the base as in *Œ. angustipennis.*

This species was described by Mr. Davis in *Canadian Entomologist,* Vol. XXXIX, p. 173, 1907. Specimens sent to him by the writer were pronounced to be of that species. Collected on trunks of trees in company with *Œ. angustipennis.* New Haven, 20 August to 12 October (B. H. W.).

**Œ. fasciatus** Fitch. *Œ. nigricornis* Walker. Striped Tree Cricket. Plate XI, 11.

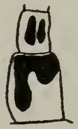

FIG. 64. *Œcanthus fasciatus.* Basal joints of antenna, showing markings.

General color greenish yellow, the body and legs often darker. Head and pronotum with from one to three longitudinal diffused black lines, often entirely black. Antennæ about two and one-half times the length of the body. Entirely black or with two black marks on each of the two basal segments. The inner mark on the first joint twice as long as the other mark, with which it is often united at the apical end of the joint. Tegmina somewhat narrower than those of *niveus.* Apical spines of posterior tibiæ stronger and more acute than in allied species. Ovipositor slightly upcurved towards apex.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 12 | 3 | 12 | 9 | 6 |
| Male | 12.5 | 3 | 12 | 9.5 | |

Our most common species; found on tall weeds and bushes along the roadsides, fence-corners, and the edges of swamps. Much of the damage credited to *niveus* may be due to this species. The writer has observed *fasciatus* ovipositing in *Spiræa* sp. in a nursery. Occurs throughout the state.

**Œ. quadripunctatus** Beutenmüller. Four-spotted Tree Cricket.

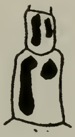

FIG. 65. *Œcanthus quadripunctatus.* Basal joints of antenna, showing markings.

Pale yellowish green in color; antennæ light brown, two basal joints each with two black marks on under side; the inner mark on first joint about two-thirds the length of the joint, the upper end curving towards but not uniting with the outer mark, which is small and nearly round. The marks on second joint parallel, the inner mark about twice the length of the outer. Wing covers very narrow.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 11.5 | 2.5 | 10 | 8.5 | 5.2 |
| Male | 11.5 | 2.5 | 11 | 8 | |

This species is found in similar locations with *fasciatus*, and is our next most common species. Occurs throughout the state from August to October.

**Œ. pini** Beutenmüller.

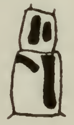

FIG. 66. *Œcanthus pini.* Basal joints of antenna, showing markings.

"Head and antennæ testaceous, the latter becoming darker towards the tip; first two joints with four black marks; the inner mark on the first joint long and straight, the outer oblique; those on the second joint parallel; eyes black; thorax testaceous with a longitudinal line on each side above; anterior pair of legs testaceous; posterior femora green, tibiæ testaceous; body beneath black with the sides yellowish green; body above blackish with a green stripe along the back; elytra transparent, with grass-green veins; hind wing slightly protruding beyond the elytra; veins also green. The female is somewhat paler than the male, and the wings extend a little more beyond the elytra; ovipositor dark testaceous, tip black. Average length from head to tip of wing-covers, 14 mm.; body, 12 mm.; width, 4.5 mm. Somewhat resembles *Œ. nigricornis,** but may readily be distinguished from it by the grass-green color of the wings and the testaceous head and thorax, and marks on basal joints of the antennæ. This insect lives only on pine trees, and usually on high branches."— Beutenmüller.

---

* *Nigricornis* is now regarded as a synonym of *fasciatus* Fitch.

*Œ. pini* was described from specimens collected at West Woodstock, September, 1893, by W. Beutenmüller.

### **Xabea** Walker.

This genus is closely related to *Œcanthus,* but may be distinguished as follows: — Antennæ without black markings, the basal joint with a blunt tooth on the under side. The veins of tegmina of female are more irregular than those in *Œcanthus.* The oblique longitudinal veins not conspicuous. Wings about twice as long as tegmina. Hind tibiæ with apical spines only. Tarsi 3-jointed, the second joint very short.

**X. bipunctata** DeGeer. Two-spotted Tree Cricket.

General color pinkish white to pinkish brown; a rather large blackish spot near the base of the tegmina in the female and another near the center; tegmina of male without spots. Wings very long, about 20 mm. Quite rare, and readily recognized by the color and the dark spots on the tegmina of the female.

Measurements.

| | Body | Pronotum | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|---|
| Female | 14 | 3 | 12 | 10 | 6 |
| Male | 14 | 3 | 12 | 10 | |

Portland, 14 August, New Canaan, 11 September (B. H. W.).

### TRIGONIDIINÆ.

Crickets of very small size. The second tarsal joint is depressed and heart-shaped instead of compressed. The calling organ of the male is more simple than in the preceding crickets, being crossed by a single oblique vein. The ovipositor is short, compressed, and sabre-like.

### **Anaxipha** Saussure.

The members of this genus look like small Nemobiids, but the females are distinguished by the compressed and strongly upcurved ovipositor, which somewhat resembles that of some of the *Locustidæ.* The antennæ are very long and bristle-like.

Wing covers of male nearly encasing the abdomen, with a round glassy spot on their apical half. Hind wings absent.

**A. exigua** Say.

Head and pronotum dark reddish brown, sparsely clothed with rather long hairs. Tegmina and legs lighter, the former reaching the tip of the abdomen in the male, shorter in the female. Abdomen of male nearly black, that of the female brown above, darker on the sides. Ovipositor dark brown, paler at tip. Cerci very long and slender with long yellow hairs.

Measurements.

| | Body | Tegmina | Hind Femora | Ovipositor |
|---|---|---|---|---|
| Female | 7 | 3.5 | 6 | 3.5 |
| Male | 6 | 4.5 | 6 | |

This pretty little cricket lives on bushes instead of on the ground, especially on or near the salt marshes. While not very common, it will probably be found by careful searching. Westbrook (in black grass), 30 August (H. L. V.).

---

NOTE — Under *Ischnoptera* should be included *I. borealis* Brunner. This roach resembles *I. uhleriana* and is considered identical by some writers. It is slightly smaller than the latter species, and in the male the supra-anal plate is broadly rounded, while that of *uhleriana* is more triangular. The supra-anal plate of the female is more obtusely angled but with the apex less rounded than that of *uhleriana*. Has been taken at Waterbury. Probably most of the records under *uhleriana* should be credited to this species.

Since this paper was in type, females of *Ischnoptera johnsoni* Rehn. (*intricata* Bl.) have been taken in the State. The female is much broader than that of *uhleriana* and darker in color (piceous). The wings reach only to the second abdominal segment, are narrow, and the inner edges separated by a distance equal to about one-half their breadth; while in *uhleriana* the inner edges of the wings of the female meet or slightly overlap.

Occurs in shady places under stones and rubbish.

New Haven, 14, 19 June (B. H. W.); Lyme, 3 July (A. B. Champlain); Southington, 12 July (W. E. B.)

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# PLATE I.

Eggs of Insects. All natural size.

1. Eggs of Lace-wing or Golden-eye, *Chrysopa oculata* Say.
2. " " Luna moth, *Tropæa luna* Linn.
3. " " Squash bug, *Anasa tristis* DeGeer.
4. " " Peach saw-fly, *Pamphilius persicum* MacG.
5. " " Rose aphis, *Nectarophora rosæ* Linn.
6. " " Senator moth, *Anisota senatoria* S. & A.
7. " " Fall canker-worm, *Alsophila pometaria* Harris.
8. " " Giant water bug, *Belostoma* (or *Benacus*).
9. " " Variegated cut-worm moth, *Peridroma saucia* Hübn.

Pupæ and Cocoons of Insects. Natural size except where otherwise stated.

10. Cocoon of Promethea moth, *Callosamia promethea* Drury.
11. Pupa of Southern tobacco worm, *Phlegethontius sextus* Johans.
12. Pupa of Northern tobacco worm, *Phlegethontius quinquemaculatus* Haw.
13. Cocoon of Mourning-cloak butterfly, *Euvanessa antiopa* Linn.
14. Cocoon of Chain-dotted geometer moth, *Cingilia catenaria* Drury.
15. Pupa of a Syrphid fly, *Baccha fascipennis* Wied. (Twice natural size.)
16. Pupa of a long-horned beetle, *Orthosoma brunneum* Forst.

Plate 1a

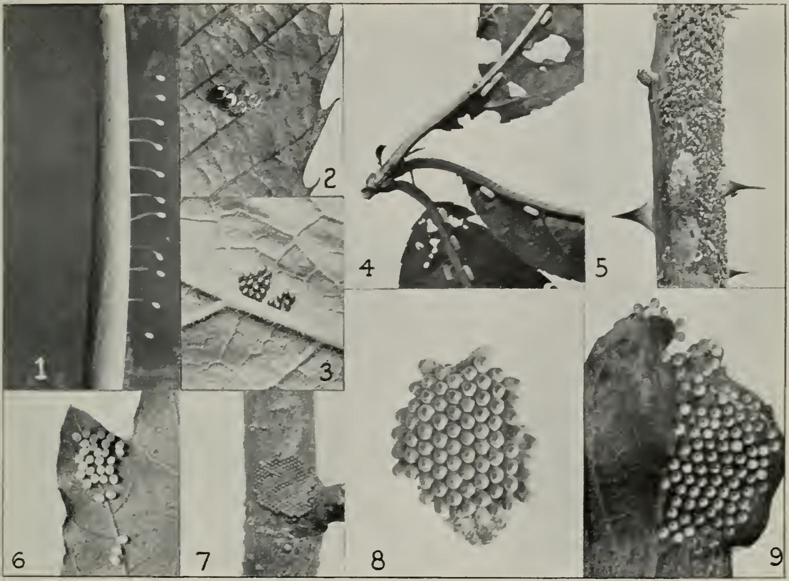
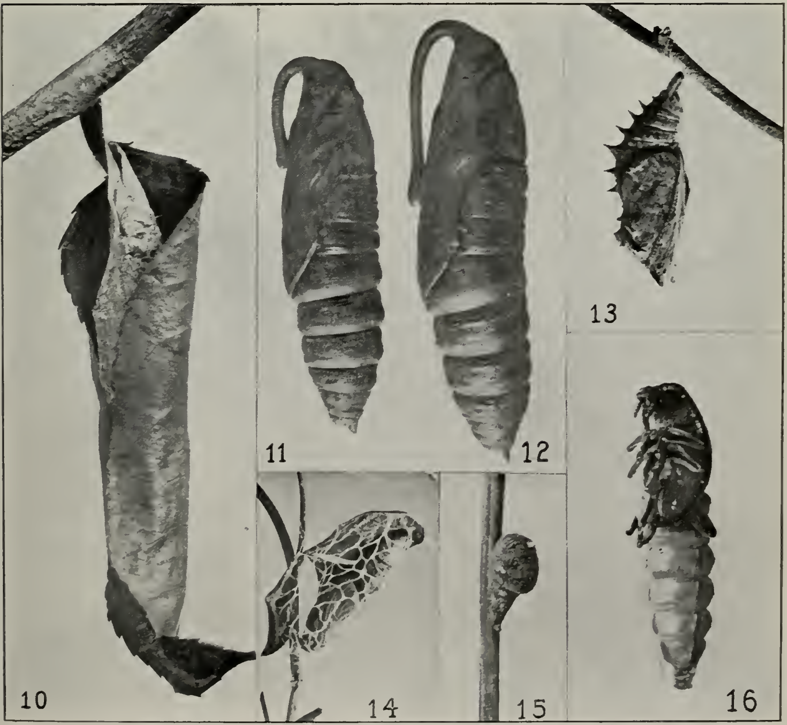


Plate 1b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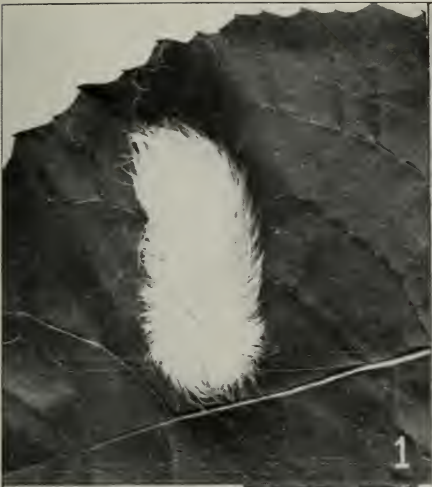
## PLATE II.

LARVÆ (CATERPILLARS AND GRUBS) OF INSECTS. All natural size.

1. Larva of a Notodontid moth, *Apatalodes torrefacta* S. & A.
2. " " Abbott sphinx, *Sphecodina abbotii* Swains.
3. " " Elm-tree sphinx, *Ceratomia amyntor* Geyer.
4. " " a long-horned beetle, *Orthosoma brunneum* Forst.
5. " " a scarab beetle, *Ligyrus relictus* Say.

Plate II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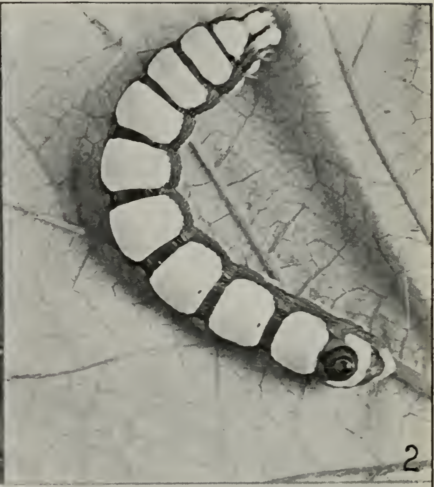
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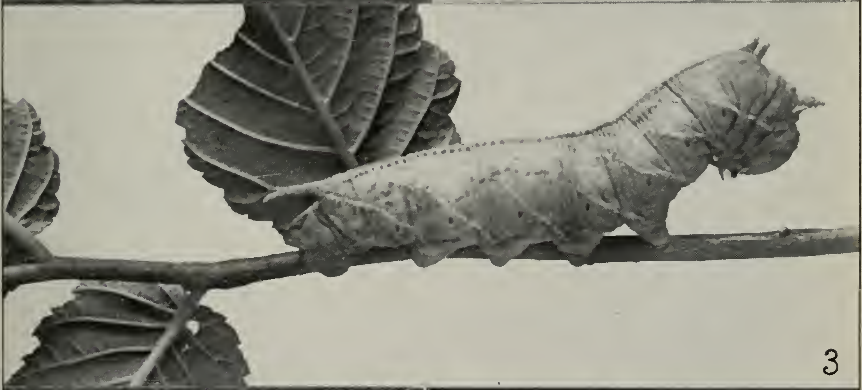
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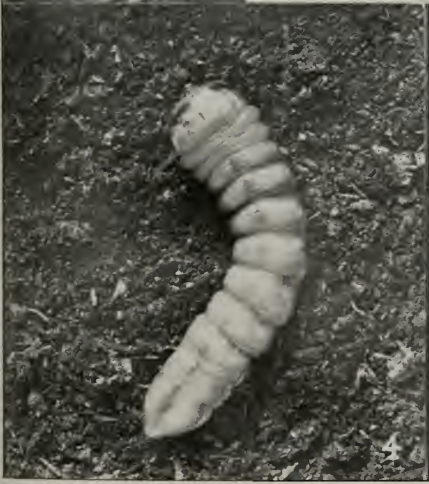
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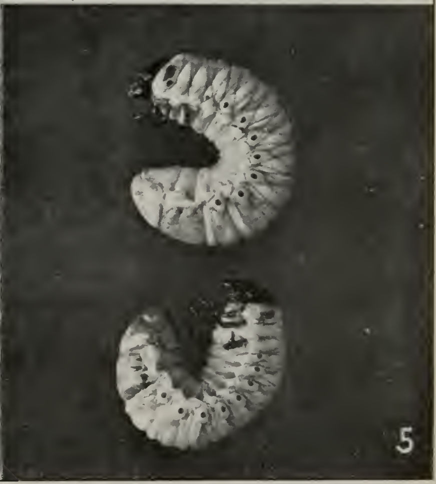
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# PLATE III.

## ODONATA.

1. *Æschna constricta* Say.
2. *Libellula pulchella* Drury.
3. *Perithemis domitia* Drury.
4. *Calopteryx maculata* P. Beauv.
5. *Celithemis elisa* Hagen.

## ORTHOPTERA.

6. *Diapheromera femorata* Say.
7. *Melanoplus femur-rubrum* De G.
8. *Melanoplus bivittatus* Say.
9. *Œcanthus nigricornis* Walk.
10. *Scudderia furcata* Brunn.
11. *Dissosteira carolina* Linn.
12. *Tettigidea parvipennis* Harris.
13. *Gryllus abbreviatus,* var. *luctuosus* Serv.
14. *Ischnoptera pennsylvanica* De G.

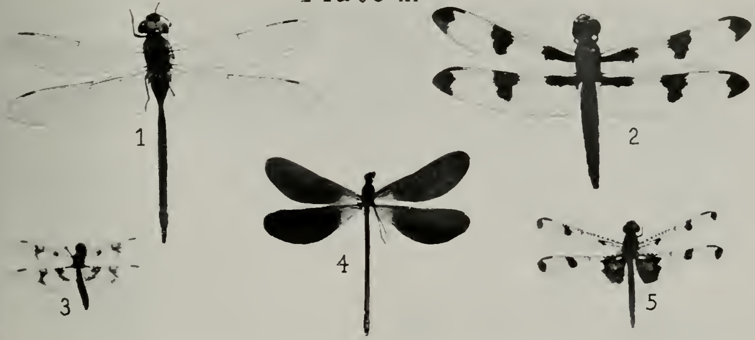
## NEUROPTERA.

15. *Chauliodes pecticornis* Linn.
16. *Corydalis cornutus* Latr.
17. *Chrysopa oculata* Say.
18. *Myrmeleon immaculatus* De G.

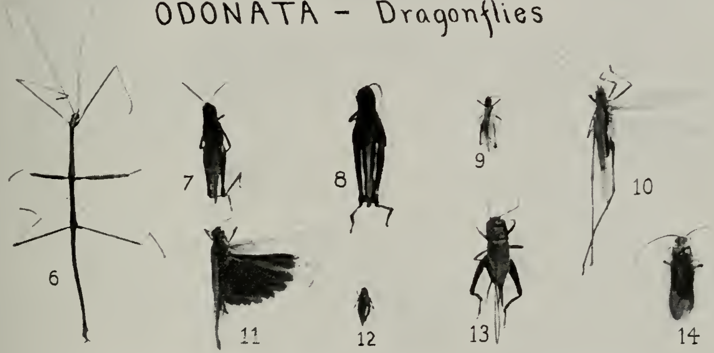
## HEMIPTERA.

19. *Benacus griseus* Say.
20. *Gerris remigis* Say.
21. *Anasa tristis* De G.
22. *Eulecanium corni* Bouché.
23. *Brochymena quadripustulata* Fabr.
24. *Euschistus variolarius* P. Beauv.
25. *Ceresa bubalus* Fabr.
26. *Gypona flavilineata* Fitch.
27. *Calocoris rapidus* Say.
28. *Cicada canicularis* Harris.

## Plate III



ODONATA - Dragonflies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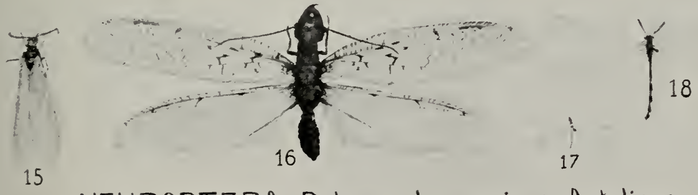
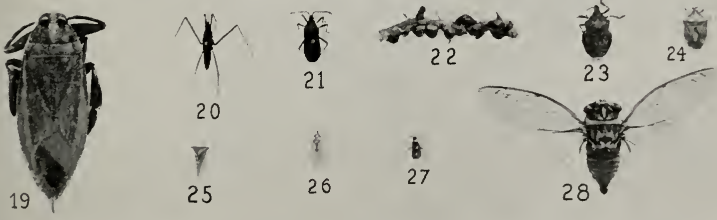
ORTHOPTERA-Cockroaches, Grasshoppers, Crickets



NEUROPTERA-Dobsons, Lace-wings, Ant-lions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HEMIPTERA- Bugs, Leaf-hoppers, Aphids, Scale-insects

## PLATE IV.

## LEPIDOPTERA.

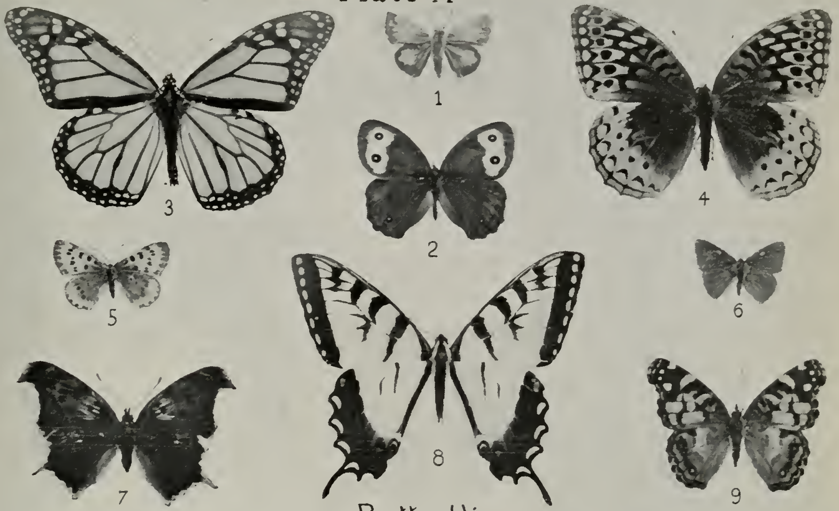
### BUTTERFLIES.

1. *Atrytone hobomok* Harr.
2. *Cercyonis alope* Fabr.
3. *Anosia plexippus* Linn.
4. *Argynnis cybele* Fabr.
5. *Chrysophanus thoe* Boisd.
6. *Strymon (Thecla) titus* Fabr.
7. *Polygonia interrogationis* Fabr.
8. *Papilio glaucus turnus* Linn.
9. *Vanessa huntera* Fabr.

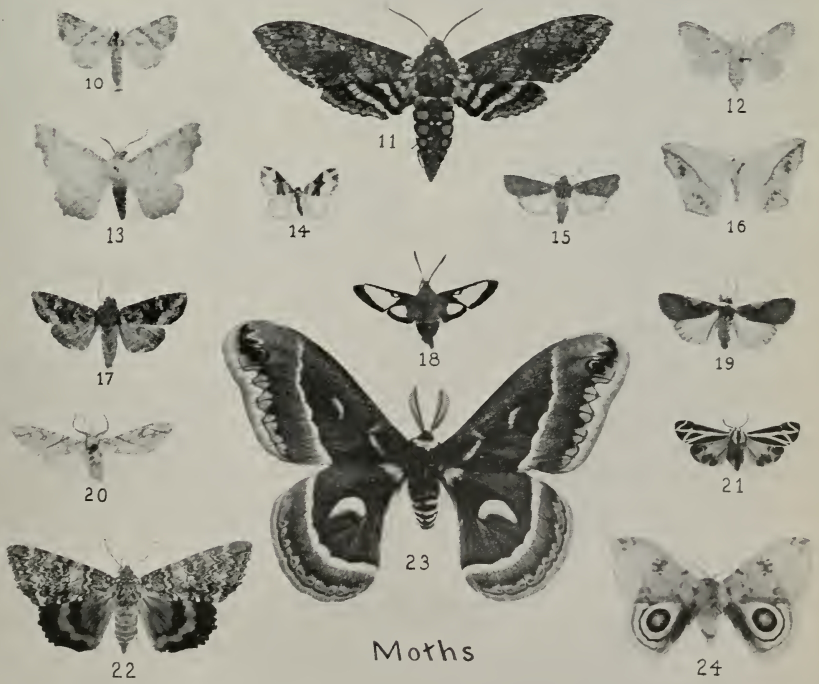
### MOTHS.

10. *Melalopha inclusa* Hübn.
11. *Phlegethontius sextus* Johans.
12. *Malacosoma americana* Fabr.
13. *Ennomos magnarius* Guen.
14. *Mesoleuca lacustrata* Guen.
15. *Paragrotis messoria* Harris.
16. *Sabulodes transversata* Drury.
17. *Hadena arctica* Boisd.
18. *Hemaris gracilis* G. & R.
19. *Noctua c-nigrum* Linn.
20. *Halisidota caryæ* Harris.
21. *Apantesis nais* Drury.
22. *Catocala unijuga* Walk.
23. *Samia cecropia* Linn.
24. *Automeris io* Fabr.

Plate IV



Butterflies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Moths

LEPIDOPTERA

## PLATE V.

### DIPTERA.

1. *Dasyllis grossa* Fabr. (*tergissa* Say).
2. *Proctacanthus philadelphicus* Macq.
3. *Tipula abdominalis* Say.
4. *Chrysopila thoracica* Fabr.
5. *Tabanus atratus* Fabr.
6. *Exoprosopa fasciata* Macq.
7. *Musca domestica* Linn.
8. *Psorophora ciliata* Fabr.
9. *Pollenia rudis* Fabr.
10. *Tabanus lineola* Fabr.
11. *Eristalis tenax* Linn.
12. *Syrphus torvus* O. S.
13. *Spilomyia fusca* Loew.
14. *Calliphora erythrocephala* Meig.
15. *Echinomyia algens* Wied.

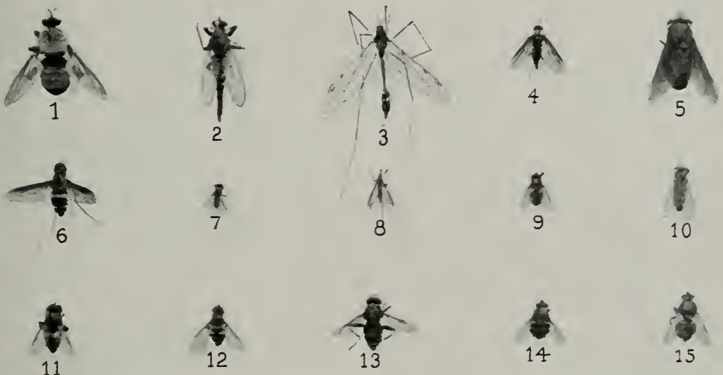
### COLEOPTERA.

16. *Dytiscus verticalis* Say.
17. *Lachnosterna fraterna* Harris.
18. *Calosoma scrutator* Fabr.
19. *Copris anaglypticus* Say.
20. *Alaus oculatus* Linn.
21. *Staphylinus maculosus* Grav.
22. *Orthosoma brunneum* Forst.
23. *Leptinotarsa decem-lineata* Say.
24. *Necrophorus americanus* Oliv.
25. *Euphoria inda* Linn.
26. *Osmoderma scabra* P. Beauv.
27. *Crioceris duodecim-punctata* Linn.
28. *Parandra brunnea* Fabr.
29. *Saperda candida* Fabr.
30. *Cicindela formosa*, var. *generosa* Dej.
31. *Blepharida rhois* Forst.
32. *Chalcophora virginiensis* Dru.

### HYMENOPTERA.

33. *Cimbex americana* Leach.
34. *Sphecius speciosus* Dru.
35. *Tremex columba* Linn.
36. *Camponotus pennsylvanicus* De G.
37. *Pelecinus polyturator* De G.
38. *Sphex ichneumonia* Linn.
39. *Apis mellifera* Linn.
40. *Psilomastix exesorius* Brullé.
41. *Polistes pallipes* Lepeletier.
42. *Vespa diabolica* Saus.
43. *Bombus pennsylvanicus* De G.

## Plate V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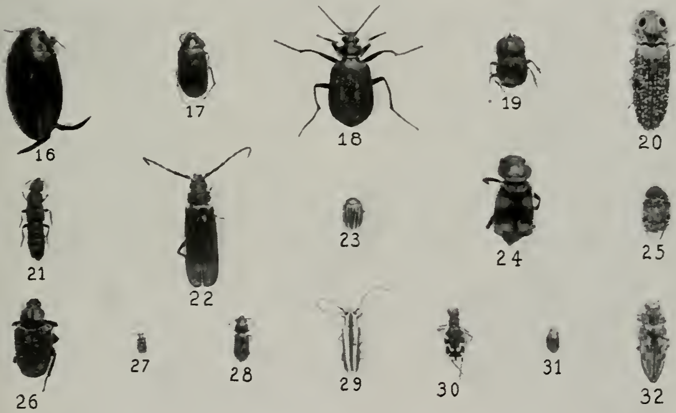
DIPTERA – Flies, Mosquitoes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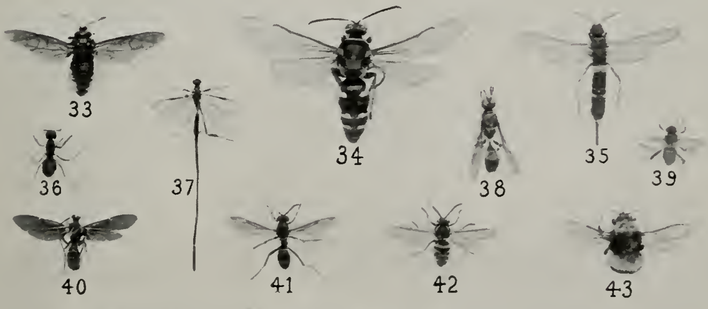
COLEOPTERA – Beetles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HYMENOPTERA – Bees, Wasps, Ants

## PLATE VI.

1. *Tenodera sinensis* Saussure, Male.
2. Egg-mass of *T. sinensis* Saussure.
3. *Mantis religiosa* Linnæus (after Slingerland).
4. *Cyrtophyllus perspicillatus* Linnæus. Male.

Plate VI

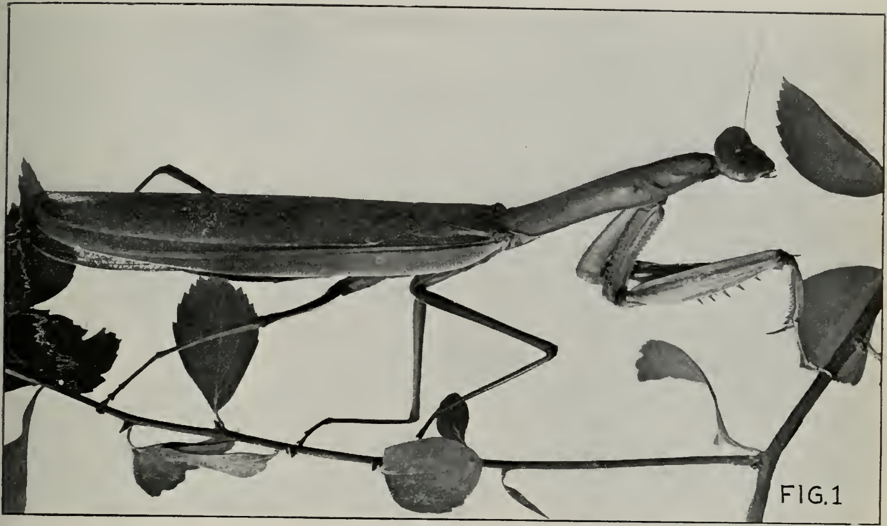


FIG. 1

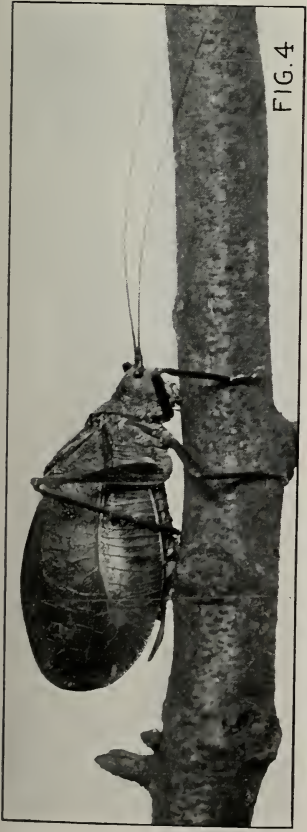


FIG. 4

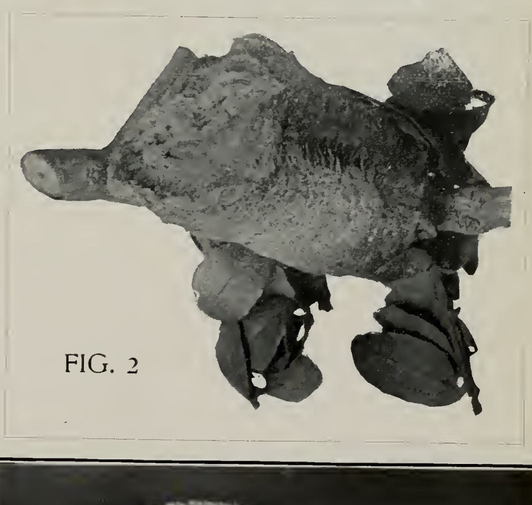


FIG. 2

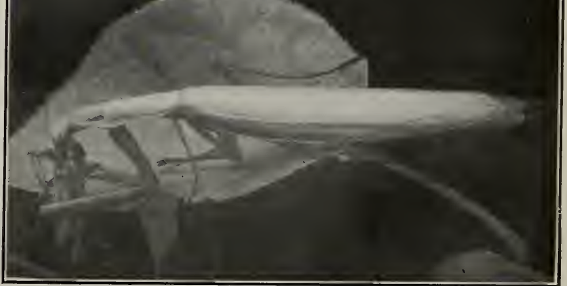
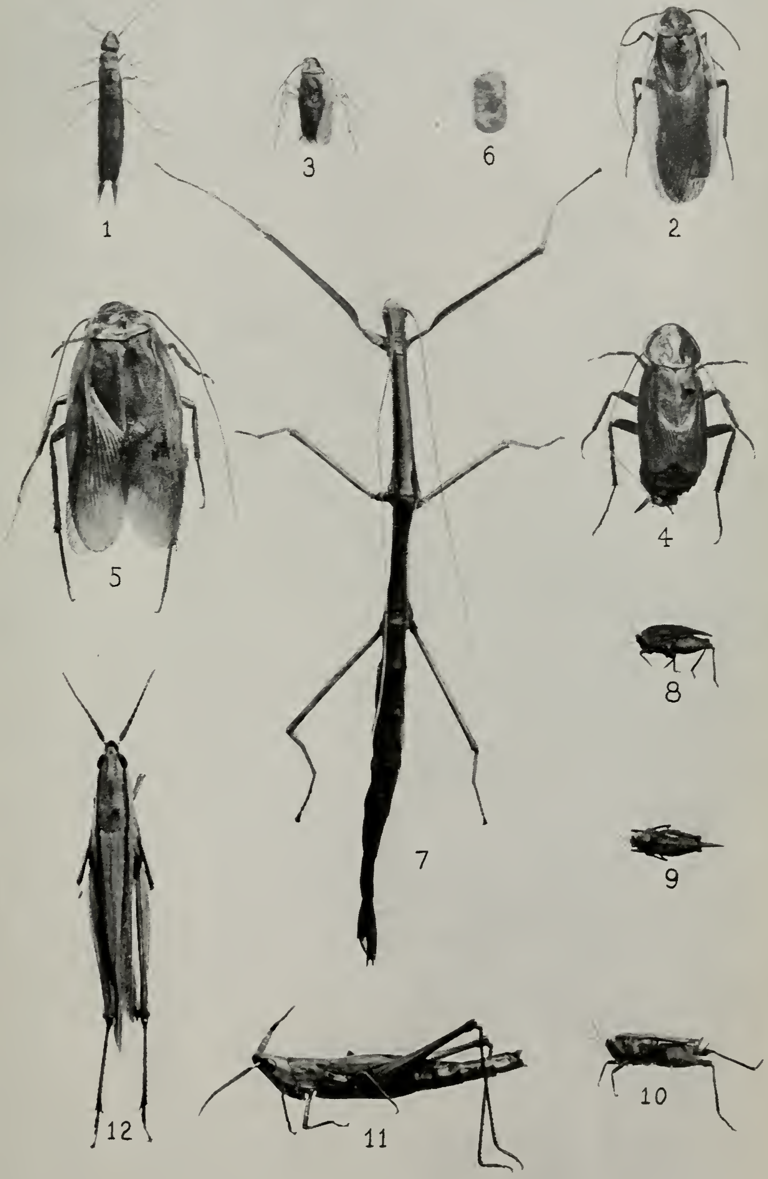


FIG. 3

## PLATE VII.

1. *Anisolabis maritima* Bonnell.
2. *Ischnoptera pennsylvanica* De Geer, Male.
3. *Blattella germanica* Linnæus, Male.
4. *Blatta orientalis* Linnæus, Male.
5. *Periplaneta americana* Linnæus, Male.
6. Oötheca or egg case of a cockroach.
7. *Diapheromera femorata* Say, Female.
8. *Nomotettix cristatus* Scudder, Female.
9. *Tettix ornatus* Say, Female.
10. *Tettigidea parvipennis* Harris, Female.
11. *Pseudopomala brachyptera* Scudder, Female.
12. *Tryxalis brevicornis* Linnæus, Female.

Plate VII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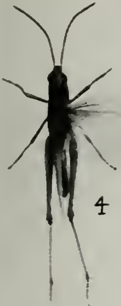
## PLATE VIII.

1. *Dichromorpha viridis* Scudder, Female.
2. *Orphulella speciosa* Scudder, Female.
3. *Chloealtis conspersa* Harris, Male.
4. *Stenobothrus curtipennis* Harris, Male.
5. *Arphia xanthoptera* Germar, Male.
6. *Chortophaga viridifasciata* De Geer, Female.
7. *Camnula pellucida* Scudder, Female.
8. *Hippiscus tuberculatus* Palisot de Beauvois, Female.
9. *Hippiscus tuberculatus* Palisot de Beauvois, Male.
10. *Scirtetica marmorata* Harris, Female.
11. *Circotettix verruculatus* Kirby, Male.

# Plate VIII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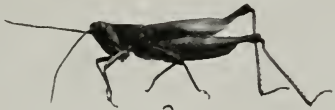
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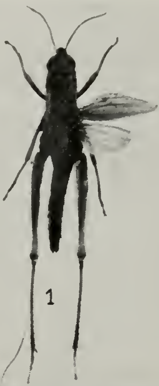
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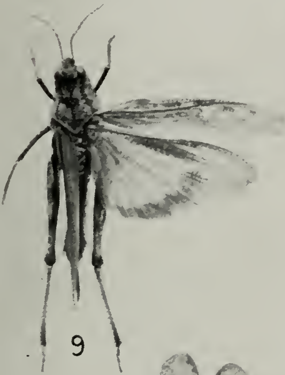
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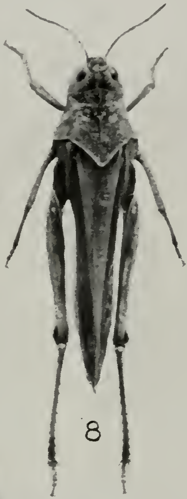
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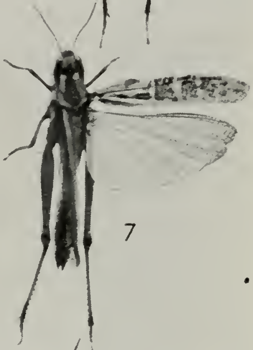
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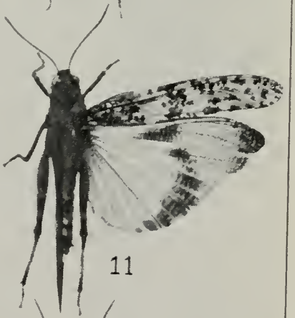
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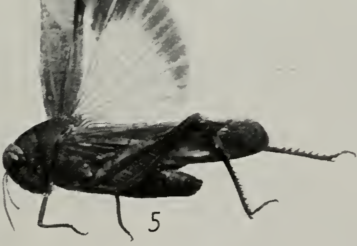
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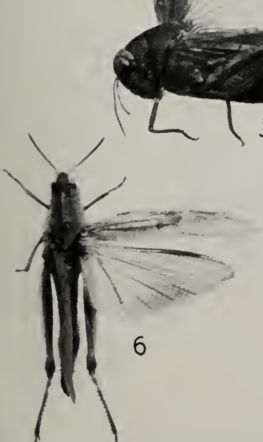
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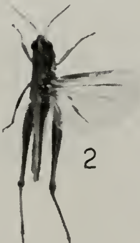
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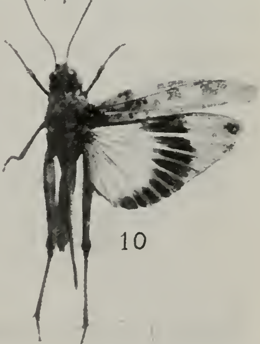
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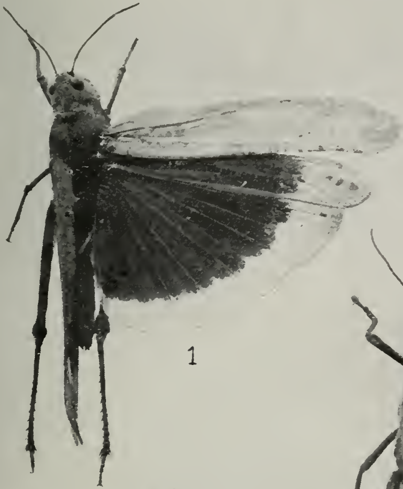
## PLATE IX.

1. *Dissosteira carolina* Linnæus. Female.
2. *Spharagemon bolli* Scudder. Female.
3. *Trimerotropis maritima* Harris. Female.
4. *Schistocerca americana* Drury. Female.
5. *Schistocerca alutacea* Harris. Female.
6. *Schistocerca rubiginosa* Harris. Male.
7. *Melanoplus scudderi* Uhler. Female.
8. *Melanoplus femur-rubrum* De Geer. Female.

# Plate IX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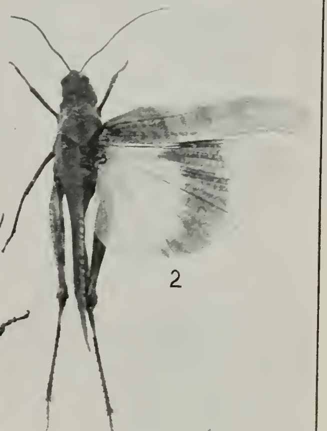
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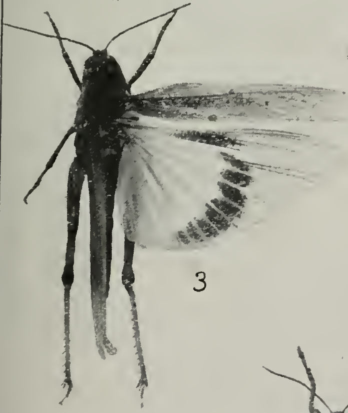
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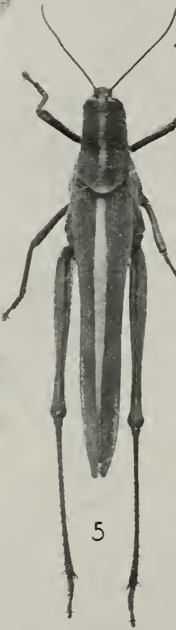
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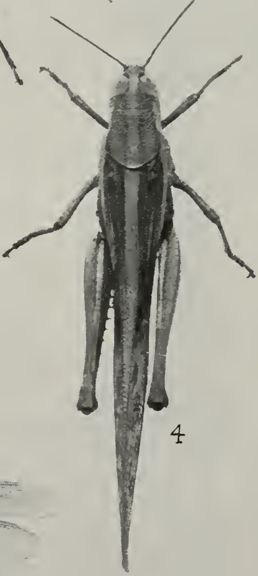
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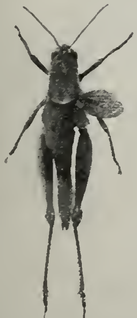
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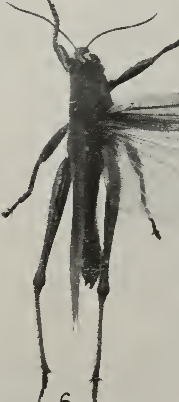
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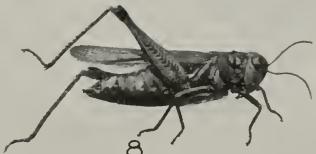
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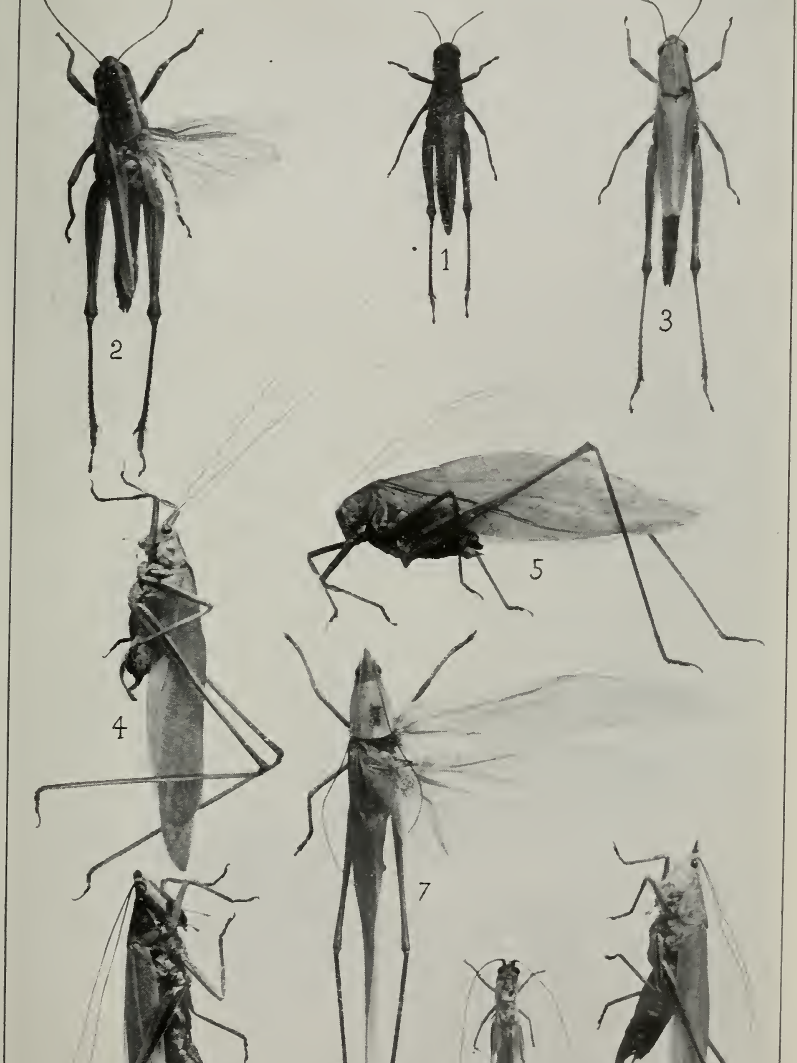
## PLATE X.

1. *Melanoplus atlanis* Riley, Female.
2. *Melanoplus bivittatus* Say, Female.
3. *Paroxya floridana* Thomas, Female.
4. *Scudderia curvicauda* De Geer, Male.
5. *Amblycorypha oblongifolia* De Geer, Male.
6. *Conocephalus ensiger* Harris, Female.
7. *Conocephalus robustus* Scudder, Male.
8. *Conocephalus triops* Linnæus, Female.
9. *Xiphidium fasciatum* De Geer, Male.

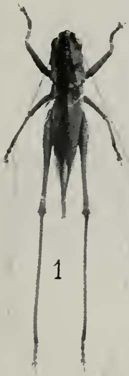
# Plate X



## PLATE XI.

1. *Orchelimum vulgare* Harris, Female.
2. *Atlanticus pachymerus* Burmeister, Male.
3. *Ceutophilus.*
4. *Gryllotalpa borealis* Burmeister, Male.
5. *Tridactylus terminalis* Uhler.
6. *Nemobius fasciatus* De Geer, Female.
7. *Nemobius fasciatus* De Geer, Male.
8. *Gryllus abbreviatus* Serville, Female (form *luctuosus*).
9. *Œcanthus angustipennis* Fitch, Male.
10. *Œcanthus angustipennis* Fitch, Female.
11. *Œcanthus fasciatus* Fitch, Female.

# Plate XI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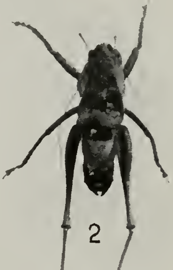
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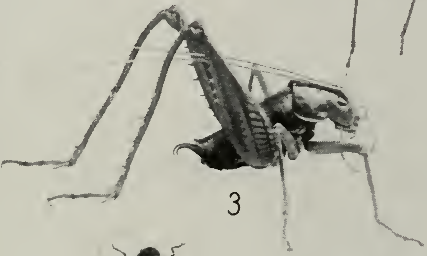
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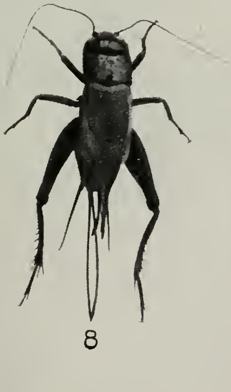
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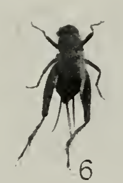
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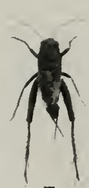
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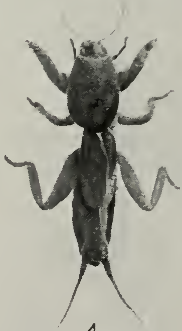
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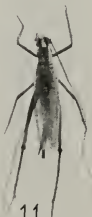
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State of Connecticut

# FOURTH BIENNIAL REPORT OF THE COMMISSIONERS

OF THE

# State Geological and Natural History Survey

1909-1910

BULLETIN No. 17

# State of Connecticut.
## PUBLIC DOCUMENT No. 47

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# State Geological and Natural History Survey

COMMISSIONERS

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CHARLES LEWIS BEACH, President of Connecticut Agricultural College

SUPERINTENDENT

WILLIAM NORTH RICE

## BULLETIN No. 17

HARTFORD
Published by the State
1910

PUBLICATION

APPROVED BY

THE BOARD OF CONTROL.

Press of The Case, Lockwood & Brainard Company

# FOURTH BIENNIAL REPORT OF THE COMMISSIONERS

OF THE

# State Geological and Natural History Survey of Connecticut

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1909 - 1910

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HARTFORD
Published by the State
1910

Hartford, Conn., December 31, 1910.

His Excellency, Frank B. Weeks, Governor of Connecticut,
*Hartford, Connecticut.*

*Sir:* — I have the honor to transmit to you herewith, in behalf of the Connecticut Geological and Natural History Survey Commission, the report of the Superintendent of the work, covering the period of two years ending December 31, 1910.

Very respectfully,

FLAVEL S. LUTHER,
*Secretary of the Commission.*

# STATE GEOLOGICAL AND NATURAL HISTORY SURVEY

## FOURTH BIENNIAL REPORT

### SCOPE AND PLAN OF THE SURVEY

There has been no change in the general scope and plan of the Survey since its first organization. It may, however, be convenient briefly to recapitulate what has been said thereon in former reports. The Survey was established by an act approved June 3, 1903. That act proposed for the Survey two subjects for investigation; viz., the geology of the state, and the natural history, or botany and zoölogy, of the state. It has been presumed to be the intent of the law that the appropriation should be divided with some approach to equality between geology and biology. The law establishing the Survey proposes definitely three aims with reference to which the work should be prosecuted: — first, the purely scientific aim of advancing our knowledge of the geology and natural history of the state; second, the economic aim of leading to the most effective conservation and utilization of the resources of the state; third, the educational aim of promoting the work of the schools of the state by the publication of the results of investigation in a form adapted for the use of teachers.

The plan of organization which was outlined in the first report has been retained. Only one salaried officer has been appointed by the Commissioners; viz., the Superintendent. Other scientific men have been engaged to investigate particular subjects and prepare reports or bulletins thereon. In the great majority of cases, the terms of contract with these scientific men have been that the investigator should receive a certain sum as compensation when the bulletin presented was accepted by the Superintendent, and that a certain allowance should also be made for the expenses of the work, the allotment for expenses to be drawn upon from time to time as the expenses were actually

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incurred. This allowance for expenses has been understood to be available for necessary travel, for the employment of stenographic or other clerical assistance, or for the employment of students or scientific men of less experience who could do some part of the work under the direction of the responsible investigator. In some cases, however, this form of contract has been impracticable, as investigations have been commenced and prosecuted in regard to which it could not be foreseen how soon they would result in conclusions definite enough for publication. In such cases the agreement has been to pay the investigator a small sum per diem, a maximum limit being prescribed in every such case.

Each report prepared is published as a separate bulletin, the bulletins being numbered consecutively, generally in the order in which they are received. Each bulletin bears the name of the author or the names of the authors, and each author is responsible for his own work. The bulletins are issued in paper covers, but a part of the edition is reserved for binding. Bulletins 1 to 5 have been bound as Vol. I., and Bulletins 6 to 12 as Vol. II. It is expected that Bulletins 13 to 17 will constitute Vol. III. The bound volumes are especially desirable for public libraries and similar institutions, in which complete sets of our publications are to be preserved. The pamphlet form, in which each bulletin is complete in itself, is convenient for the large number of students, teachers, and others who have use for some particular bulletin. The publications of the Survey are distributed by the State Librarian. They are given liberally to colleges, public libraries, geological surveys, and other scientific institutions, and to scientific men of repute in the branches of science with which the respective bulletins are concerned. In many cases publications of great value are received in exchange for the publications of the Survey. All books and papers thus received are deposited in the State Library. The publications of the Survey are also distributed liberally to citizens of our own state, particularly to teachers who can make use of them in their work. In the case of persons in other states who are not known as scientific men, and who appear to have no special claim for the donation of the publications of the Survey, the bulletins are sold at prices sufficient to cover the cost of printing and transportation.

## BULLETINS ALREADY PUBLISHED

The three previous biennial reports of the Commissioners are numbered respectively in the series as 1, 9, and 12.

Four bulletins on scientific subjects were published between the dates of publication of the first and the second biennial report. These were the following: —

No. 2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.

No. 3. A Preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.

No. 4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.

No. 5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.

Five bulletins were published between the dates of publication of the second and the third biennial report. These were the following: —

No. 6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.

No. 7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory, and Henry Hollister Robinson.

No. 8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.

No. 10. A Preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn and Lucia Washburn (Hazen) Webster.

No. 11. The Bryophytes of Connecticut: by Alexander William Evans and George Elwood Nichols.

Two bulletins have been published since the date of publication of the third biennial report. These are the following: —

No. 14. Catalogue of the Flowering Plants and Ferns of Connecticut, growing without cultivation: by Charles Burr Graves, Edwin Hubert Eames, Charles Humphrey Bissell, Luman Andrews, Edgar Burton Harger, and Charles Alfred Weatherby, Committee of the Connecticut Botanical Society.

No. 15. Second Report on the Hymeniales of Connecticut: by Edward Albert White, Professor of Floriculture in Massachusetts Agricultural College.

The Catalogue of the Flowering Plants and Ferns is, particularly from an educational point of view, one of the most important bulletins the Survey has published. The Connecticut Botanical Society includes about one hundred members, some of them professional botanists, others amateur students of the science. For a number of years the members of this Society have given a great deal of time to the collection and study of the flowering plants and ferns of the state, and the work of the various members has been carefully collated by a Committee whose names are given above in the title of the bulletin. Soon after the organization of the Geological and Natural History Survey, the Superintendent of the Survey learned of the proposed work of the Connecticut Botanical Society, and invited them to offer the Catalogue, when completed, to be published as a bulletin of the Survey. The entire work has been a labor of love on the part of the members of the Committee and many of their associates. The Survey has paid three hundred dollars for incidental expenses, but no compensation has been received by any of the workers. The completed work makes a book of five hundred and sixty-nine pages. It gives a list complete, according to present knowledge, of the flowering plants and ferns (including the closely allied club mosses and scouring rushes) growing without cultivation within the limits of the state. The scientific names adopted for the respective plants, are, in general, the same which are used in the Seventh Edition of Gray's Manual, a book which is widely accepted as a standard in the schools. While no attempt has been made to give a complete record of synonyms, the names which have been in somewhat general use are given as a matter of convenience. English names of the different species are very fully given, including, so far as known, the often whimsical names in use in particular localities or among particular classes of people. Full information is given in regard to the distribution of the plants over the state. In the case of rare species, and species local or peculiar in distribution, particular localities are mentioned with the names of the collectors. Attention is called to all plants having important economic relations, both those which are useful, and those which are injurious. Analytical keys and descriptions are not included in the work, since the Seventh Edition of Gray's Manual is readily accessible and cheap, and will doubtless be in the hands of almost everyone who would wish to use this book. In the introduction is given an interesting history of botanical work in the state from the earliest days; and in an appendix is included a statistical summary of the plants of Connecticut.

The work of Professor White on the Hymeniales is a supplement to the Preliminary Report on the Hymeniales by the same author, published in 1905, as Bulletin No. 3. The plants treated in these two reports are the fleshy and woody fungi, some of which are edible mushrooms, while others are extremely poisonous. The present bulletin consists of three parts. The first part gives analytical keys for the discrimination of the species of the Agaricaceæ — the most important family of the group, and the one which includes most of the edible species. The second part gives detailed descriptions of some of the edible species of mushrooms. The third part gives a list of all the species of Hymeniales which have been discovered in the state since the publication of the former Bulletin. Both of these bulletins are illustrated with beautiful plates, exhibiting the aspect of many of the species, from original photographs by the author. The study of mushrooms has been very popular in recent years, and Professor White's former bulletin has attracted much attention. Doubtless all who have found the former bulletin useful will want to avail themselves of the present supplementary report.

## BULLETINS IN PRESS

Two Bulletins are passing through the press at the date of the present report. These are the following: —

No. 13. The Lithology of Connecticut: by Joseph Barrell, Professor of Structural Geology in Yale University, and Gerald Francis Loughlin, Instructor in Geology in Massachusetts Institute of Technology.

No. 16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton, State Entomologist, and Entomologist of the Connecticut Agricultural Experiment Station. Part I. General Introduction: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden, Assistant in Entomology, Connecticut Agricultural Experiment Station.

The bulletin on the Lithology of Connecticut includes a general introduction to lithology by Professor Barrell, and a special description of forty-one typical rocks from Connecticut localities by Dr. Loughlin. In the general part of the work, lithology is treated in relation to mineralogy and dynamical geology, so that the student may learn somewhat of the agencies by which the different types of rocks are produced, as well as their composition and characteristic aspect. Both in the general and the special part of the work attention is given chiefly to those characteristics of rocks which can be recognized by the naked eye or by the simple microscope, with comparatively little reference to the phenomena which can be observed only by the examination of thin sections under the compound polarizing microscope. This limitation in the treatment of the subject renders the work adapted to the use of comparatively elementary students. The usefulness of the work in the high schools and other institutions in the state will be greatly enhanced by the distribution to those institutions of suites of specimens of rocks from the typical localities described in the special part of the paper. These specimens were for the most part collected in the summers of 1905 and 1906. They will be distributed, as soon as the bulletin is published, to colleges, normal schools, high schools, and academies in the state, on condition that the respective institutions shall pay the cost of transportation. Any suites of specimens remaining in the possession of the Survey after such distribution may be sold and the money paid into the treasury of the state.

The bulletin on the Insects of Connecticut forms the beginning of a series of papers on that class of animals, whose publication may be distributed through a considerable number of years. It is needless to comment on the economic importance of the class of insects, many insects being among the worst enemies of the agriculturist, while others, insectivorous or parasitic in habit, tend to hold in check the destroyers of agricultural products. The various parts of the work will be written by specialists on various groups, under the general direction of Doctor Britton. The present bulletin includes two parts of the proposed work. Part I. gives a brief outline of the general characters of insects and their relations to other allied groups of animals, the classification of the group, and their economic relations. In Part II., Mr. Walden gives a catalogue, with analytical keys, of the two orders, Euplexoptera and Orthoptera. The former order is a small and comparatively insignificant one, including the insects commonly called earwigs. By many entomologists the Euplexoptera have been regarded as merely a subdivision of the Orthoptera. The Orthoptera constitute a larger and more important order, including, besides some less familiar forms, the cockroaches, the locusts and grasshoppers, the katydids, and the crickets. The mere mention of the names, locust and grasshopper, is enough to suggest the importance of the economic relations of the Orthoptera. Part I. of this bulletin is illustrated by a series of plates, representing typical examples of all the principal orders of insects. Part II. is illustrated by a number of plates from photographs of entire insects representing different groups of Orthoptera, and by numerous figures in the text from drawings of diagnostic parts of the anatomy of various families and genera.

## BULLETINS ACCEPTED FOR PUBLICATION.

The following Bulletins have been accepted for publication: —

Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton, State Entomologist, and Entomologist of the Connecticut Agricultural Experiment Station. Part III. Hymenoptera of Connecticut: by Henry Lorenz Viereck, of the United States National Museum.

The Triassic Fishes of Connecticut: by Charles Rochester Eastman, Curator of Vertebrate Paleontology in the Museum of Comparative Zoölogy, Harvard University.

The Echinoderms of Connecticut: by Wesley Roswell Coe, Professor of Biology in Yale University.

Drainage and Glaciation in the Central Housatonic Basin: by Ruth Sawyer Harvey.

The Hymenoptera which are treated in the bulletin by Mr. Viereck, form one of the largest and most important of the orders of insects. The marvelous instincts and habits of bees, wasps, and ants have always attracted the interest of thoughtful observers. Many of the Hymenoptera are of very great economic interest. The bees, by their transportation of pollen from flower to flower, are indispensable for the fertilization and consequent propagation of a great many plants. Many of the smaller Hymenoptera, as the ichneumon flies, are parasitic upon other insects, and thus serve to keep in check insects which would otherwise be destructive pests to the agriculturalist. Some of the Hymenoptera, on the other hand, as the saw-flies, are themselves prominent among the destroyers of agricultural products. Mr.

Viereck is himself a specialist on some of the groups of Hymenoptera, and he has also had the aid of a number of collaborators who are specialists on other groups of this large and varied order. The writers, who have contributed chapters to the work, are the following: — Alexander Dyer MacGillivray, Assistant Professor of Entomology and Invertebrate Zoölogy in Cornell University; Charles Thomas Brues, Curator of Invertebrate Zoölogy, Public Museum, Milwaukee, Wis.; William Morton Wheeler, Professor of Economic Entomology in Harvard University.

The bulletin on the Triassic Fishes, by Dr. Eastman, is a very important contribution to the paleontology of the state. The area of Connecticut is by no means rich in fossils. The crystalline rocks of the eastern and western highlands have proved as yet utterly barren of fossils. Whatever fossils some of these rocks may have once contained have been entirely obliterated by the processes of metamorphism. The Triassic formation of the Connecticut Valley has afforded scarcely any fossils, excepting tracks of reptiles and amphibians on some of the beds, and remains of fishes and a few species of plants in two or three thin strata of black shale intercalated among the red shales and sandstones. The scantiness of fossils in this formation has made difficult the determination of its geological age. Dr. Eastman has made a very careful study of all the important collections of the fossil fishes of this formation. He has been able thus to make a more exact determination of some features of the anatomy of the animals than has been made before. He has also made comparisons of the fish fauna of our Connecticut beds with the fish faunas of other Triassic formations in various parts of the world. This comparison leads him to the opinion that the age of our Connecticut formation corresponds most nearly, not with the uppermost European Trias (Keuper or Rhætic), but rather with a somewhat lower horizon, near the boundary between the Muschelkalk and the Keuper.

The bulletin by Professor Coe on the Echinoderms of Connecticut will be the first paper which the Survey has published on the marine zoölogy of the State. The echinoderms include the creatures commonly called sea-urchins and starfishes. Though not a large class as regards the number of species, the echinoderms are an interesting group. They are among the marine animals which are large and conspicuous, and most of them have skeletons which are readily preserved. They are accordingly among the forms which attract the attention of visitors to the shore. Professor Coe's full descriptions of our species will be useful to teachers, particularly in the towns along the coast, where the pupils may easily become acquainted with these animals. One genus of the echinoderms, the common starfish, is of great economic interest, since it is one of the most destructive enemies of the oyster. Professor Coe has given much attention to the relation of the starfish to the oyster industry. The work is beautifully illustrated with plates showing the aspect of the living animals and others showing their anatomical structure.

Miss Harvey's paper on Drainage and Glaciation in the Central Housatonic Basin is a study of the changes in drainage as the result of the events of the Glacial period. It was presented as a thesis for the degree of Doctor of Philosophy in Yale University. It is the first instalment of a series of bulletins bearing on the general subject of the Quaternary geology of the state.

## WORK STILL IN PROGRESS

### *I. Geology*

The geological investigations now in progress relate chiefly to surface geology, or the study of the phenomena connected with the work of the great ice sheet of the Glacial period. For more than a generation geologists have recognized that the mantle of heterogeneous and unstratified drift covering most of New England and the adjacent country is essentially the ground moraine of a continental glacier; that the widely scattered smooth, polished, and striated rock surfaces are the result of erosion by such a continental glacier; and that the stratified deposits in the river valleys consist of the débris transported by the glacier, sorted and redistributed by the action of water. But it is within a comparatively few years that a more thorough and detailed study has been given to these glacial phenomena. Of the comparatively small amount of study that has been given to the glacial geology of Connecticut, a considerable part has been vitiated by preconceptions now known to be erroneous, leading to false interpretations of observed facts, and preventing due appreciation of phenomena which might have been observed.

There is need of a large amount of new study before the true history of the glacial and aqueo-glacial formations of the state can be determined.

Dr. F. P. Gulliver of Norwich has been at work for some time on a detailed study of the terraces bordering the estuary of the Thames. These shelves of stratified sand and gravel at a considerable elevation above the present level of the river have been supposed to be remnants of a great plain of sand and gravel which was once substantially continuous across the valley, and which was formed, after the retreat of the ice from the portion of the valley in question, by deposition in the waters of the river, whose velocity was at that time feeble by reason of diminished slope and excessive load of sediment. A number of years ago Dr. Gulliver published a preliminary paper on the terraces of the Thames, in which he gave reasons for the belief that those terraces were formed on the edges of the valley while a tongue of ice still lingered in the central part. Various students have shown reasons for a similar belief as regards the terraces in the lower or estuarine portions of other rivers of the North Atlantic slope. The study of these terraces is therefore of great interest in the endeavor to trace out the detailed history of the later stages of the ice age. Dr. Gulliver has accordingly undertaken to make a more detailed survey of the terraces of the Thames River, and to furnish the result for publication as a bulletin of the State Survey.

Numerous other problems present themselves in the detailed study of the glacial geology of this region. Studies of the glacial formations in the Mississippi Valley, in northern Europe, and in the Alpine region, have clearly revealed the fact that the Glacial period was more complex than was formerly supposed. There were repeated alternations of rigor and mildness in the climate in accordance with which the great ice sheets alternately advanced and retreated. The deposits of earlier ice sheets can be recognized in some regions, emerging from beneath the edge of the later deposits, while in some localities stratified and fossiliferous interglacial deposits can be recognized between the older and the younger glacial formations. In New England the latest advance of the ice sheet extended beyond the shore line, and it has been generally supposed that the latest ice invasion so thoroughly disturbed all deposits of the earlier ice sheets, as to leave no recognizable remains of them. There is need, however, of thorough study of precisely this question. There is need also of careful examination for the purpose of tracing in more detail the history of successive stages in the final recession of the ice sheet. During the summer of 1907 Professor H. E. Gregory of Yale University devoted considerable time to field work in the study of the Glacial formations of the state. As a preliminary result of this study, a bulletin on the Glacial phenomena of the Naugatuck Valley will be ready at an early date. In the Geological Map of Connecticut, which was published as Bulletin No. 7, surface geology was entirely ignored, the map representing only the bed rocks which lie beneath the mantle of drift. It is expected that Professor Gregory's work will result eventually in the preparation of another general map of the state showing the surface geology, and a volume of text tracing with some approach to completeness the history of the Glacial period in our state.

Dr. Freeman Ward of Yale University has been engaged a part of the time for two summers in special studies of the glacial geology of the New Haven region. It is expected that he will present, at an early date, a paper on that locality, while his work will also contribute material for the general work on the Quaternary geology of the state which is expected from Professor Gregory.

The melting away of the great ice sheet left the surface of Connecticut and of the adjacent country dotted with innumerable lakes and ponds, many of which have already become obliterated. One of the processes which have led to the disappearance of these ponds is the accumulation of the débris of vegetation, converting the ponds into peat bogs. The peat is not only of great scientific interest, both to the geologist and to the botanist, but possesses considerable economic importance, having uses as a fuel and as a fertilizer, and being capable also incidentally of employment for various other purposes. Attention has recently been called to the economic value of peat by the investigations of the United States Geological Survey, which have shown its special fitness for use in the gas-producer. It was, therefore, deemed desirable to make a special investigation of the peat deposits of Connecticut, and this was rendered practicable by the generous coöperation of the United States Geological Survey. During the summer of 1907 the field work of the investigation was substantially accomplished. The localities of all the important peat bogs of the state were visited, the area of those bogs was noted, their depth was determined by a sounding apparatus, and samples for analysis were collected from various depths. This work was accomplished by Messrs. E. C. Miller, A.B., and T. T. Giffen, A.B., of Yale University. Professor C. A. Davis of the United States Bureau of Mines, who was employed by the United States Geological Survey in the summer of 1907 for a reconnoissance of the peat deposits of the Atlantic border of the country from Maine to Florida, was permitted by the courtesy of the United States Geological Survey to spend a few days in Connecticut at the beginning of the season of field work. He was able, therefore, to give Messrs. Miller and Giffen the necessary instruction in regard to methods of work. The bulletin which is now nearly ready for publication, will contain a general paper on the scientific and economic relations of peat, by Professor Davis, who has made himself eminently an authority on the subject. It will also contain a digest of the notes of Messrs. Miller and Giffen in regard to their field work. A selection of samples collected by Messrs. Miller and Giffen have been analyzed in the laboratory of the United States Geological Survey, and reports of those analyses will be included in the bulletin. The State Survey is very greatly indebted to the liberality of the United States Geological Survey for the all-important assistance of Professor Davis at the beginning of the investigation, and for the analyses made in the laboratory of the United States Geological Survey. The attention which has recently been given to the scientific and economic relations of peat has brought into notice the valuable work on peat from the chemical standpoint done many years ago by Professor S. W. Johnson, the pioneer in agricultural chemistry in this country. Professor Johnson's book is out of print, and his work on peat had been almost forgotten. The forthcoming bulletin will render his important work once more accessible by the republication of the important parts of his book, edited and revised by his friend and pupil, Dr. E. H. Jenkins, Director of the Connecticut Agricultural Experiment Station.

In commenting on Dr. Eastman's bulletin on the Triassic Fishes, reference has been made to the numerous tracks of reptiles and amphibians (the so-called bird tracks) which are almost the only other fossils found in the state. Only a very few bones of the creatures that made these tracks have been discovered. Those few finds, however, have thrown much light on the nature of the animals, which was formerly more or less vaguely guessed at from the tracks. Professor R. S. Lull of Yale University, who published some years ago a very valuable study of the fossil footprints of the Connecticut valley, is continuing the study of those interesting fossils, and will present at an early date a bulletin in regard to them, which will undoubtedly be the most authoritative work on the subject that has been issued.

### *II. Botany*

Dr. G. P. Clinton of the Connecticut Agricultural Experiment Station, whose paper on the smuts was published as Bulletin No. 5, has nearly completed a paper on another important group of parasitic fungi, viz., the downy mildews. This group includes a number of parasites destructive to important agricultural products, and the bulletin will be therefore an important contribution to the economic botany of the State.

Professor Conn, whose work on the protozoa and algæ of the fresh waters of Connecticut has been published as Bulletins 2 and 10, is continuing his study of the microscopic life of the fresh waters by an investigation of the bacteria. The relation of bacteria to public health is so well understood as to make it obvious that a study of the distribution of bacteria in the reservoirs and other sources of drinking water must be of great importance from a practical as well as from a purely scientific point of view. A preliminary report on the bacteria will be presented at an early date.

### *III. Zoölogy*

Probably no work which the Survey has announced as in preparation has been awaited by so many people, in the state, and out of it, with eager expectation, as the work of Mr. John H. Sage and Dr. Louis B. Bishop on the birds of Connecticut. In their careful studies, continued for many years, a vast amount of information has been recorded in regard to the dates of arrival and departure of our migratory birds, the localities of rare birds, and the food and habits of the birds. This bulletin will be of interest not only to ornithologists, but also to teachers and farmers, and to the multitude of people who have learned to love the birds. The publication of this bulletin will help to correct some erroneous impressions, widely prevalent among farmers, in regard to some of our birds. Many of the birds of prey, for instance, which are commonly regarded as the farmer's foes, are really his friends. In fact, the sharp-shinned hawk, Cooper's hawk, and the great horned owl, are probably the only birds of prey that are in any considerable degree injurious to agriculture in Connecticut. It is matter of regret that the publication of this bulletin has been so long delayed, owing to the pressure of other duties and cares which has made it impossible for the authors to give the amount of time necessary for the completion of the work. Happily a very competent editorial assistant has been found in W. P. Bliss, M.A., of the State Bacteriological Laboratory. Mr. Bliss is himself an earnest student of the birds, and his general training has given him an excellent fitness for editorial work. He has been giving a good deal of time to collating and getting into shape for publication the notes of Mr. Sage and Dr. Bishop, and it is now hoped that this very valuable bulletin will be able to be published at an early date.

As stated above, two parts of the proposed work on the insects of Connecticut — the general introduction, and the Euplexoptera and Orthoptera — are already in press. The third part, including the Hymenoptera, has been accepted for publication. A fourth part, taking up the Hemiptera, is now in preparation by specialists under the direction of Dr. W. E. Britton. The Hemiptera include the insects popularly called bugs, as well as the cycadas, leaf-hoppers, plant-lice, and the lice infesting man and other mammals. They are mostly to be regarded as injurious insects, some of them being formidable destroyers of agricultural products, while others are troublesome parasites of man and of domestic animals.

As the completion of the Guide to the Insects of Connecticut will undoubtedly occupy many years, it has been thought that it would be desirable to publish at as early a date as practicable a check-list, giving simply the names of the insects of various orders known to occur in Connecticut. Dr. Britton is at work on the preparation of such a check-list, and it will probably be ready at an early date.

A beginning has been made in the preparation of a series of bulletins on the marine zoölogy of the state. A bulletin on the echinoderms, by Professor W. R. Coe, has already been accepted for publication. Professor A. E. Verrill of Yale University is engaged in the preparation of a bulletin on the Stalk-eyed Crustacea (Decapoda, Cumacea, and Stomatopoda). This group includes the highest in rank, the largest and most conspicuous, and the most important economically, of the crustacea. Here belong the crabs, lobsters, and shrimps. While several species of the group on our Connecticut coast are of some degree of economic importance, the common lobster is one of the most valuable of the food resources of the sea. Professor Verrill's paper will deal thoroughly with the scientific relations of the animals in question, and, particularly in the case of the lobster, will treat very fully indeed their economic relations. These large and conspicuous crustacea are exceedingly interesting objects of study, and the work will be of very great value to teachers. It will be profusely illustrated with photographs of entire animals, and drawings of important parts of the anatomy.

Next in importance to the groups of Crustacea treated by Professor Verrill are the amphipods and isopods. Most of these animals are marine, while others, as the wood-lice or sow-bugs, are terrestrial. A bulletin on these forms by Dr. B. W. Kunkel of Yale University is nearly completed. Though less conspicuous than the crabs and lobsters, these animals are large enough to be often collected by visitors to the shore, and a manual of our Connecticut species will be of much use to teachers of zoölogy in our schools.

## DISTRIBUTION OF THE APPROPRIATIONS

The expenditures for work which has been completed and for which full payment has been made since the last biennial report have been as follows: —

| Name | Work | Compensation | Expenses |
|---|---|---|---|
| W N. Rice | Superintendence, 1907-9 | $400 | $149.56 |
| C. R. Eastman | Triassic Fishes | 300 | 99.45 |
| R. S. Harvey | Glacial Geology, Housatonic Basin | 25 | 72.05 |
| Conn. Botanical Soc. | Flowering Plants and Ferns | | 299.61 |
| E. A. White | Fungi | 100 | 44.69 |
| W. R. Coe | Echinoderms | 75 | 25.00 |

The allotments for work which is still in progress, or for which full payment has not been made, are as follows: —

| Name | Work | Compensation | Expenses |
|---|---|---|---|
| W. N. Rice | Superintendence, 1909-11 | $400 | $300 |
| F. P. Gulliver | Thames River Terraces | 425 | |
| H. E. Gregory | Glacial Geology | 825 | |
| F. Ward | Glacial Geology | 400 | |
| C. A. Davis and others | Peat | 325 | 325 |
| R. S. Lull | Fossil Footprints | 200 | 100 |
| G. P. Clinton | Downy Mildews | 50 | 25 |
| H. W. Conn | Fresh-water Bacteria | 200 | 650 |
| J. H. Sage and L. B. Bishop | Birds | 200 | 400 |
| W. E. Britton and others | Insects | 625 | 250 |
| A. E. Verrill | Crustacea | 150 | 250 |
| B. W. Kunkel | Crustacea | 100 | 50 |

The small expenditure, in comparison with the quantity and quality of the work, is remarkable.

## PLANS FOR FUTURE WORK

### *I. Geology*

It may be said in general that there is need of more detailed study in most parts of the state than has yet been accomplished. The area of the state most thoroughly studied as regards the bed rocks is that of the Triassic formation. The area where detailed work is most lacking as yet is that of the eastern crystallines. The geological work which has been done in much of eastern Connecticut amounts to little more than a reconnoissance. The Manual of Geology, and the Geological Map by which it is supplemented, bear most eminently the character not of final reports, but of reports of progress. Their publication was amply justified by the need, on the part of teachers and others, for publications which would set forth in convenient and intelligible form our present knowledge of the geology of the state. But they certainly will require very much of correction in detail. It is, moreover, not unlikely that more detailed study will bring to light facts which will lead to very important changes in the general conception of the geological history which is recorded in our rocks.

The necessity for more detailed study in various parts of the state is even greater in regard to surface geology than in regard to the geology of the underlying rocks. Professor Gregory and Drs. Gulliver, Ward, and Harvey have made a beginning of such investigation; but a vast amount of careful work must be done before we can reach the true history of the Quaternary era in our territory.

A class of geological papers which would be of great educational value would be a series of geological guide-books to various regions of the state. In these guide-books directions sufficiently detailed to be practical should be given for excursions to localities where the most characteristic and instructive geological phenomena could be seen. Professor James D. Dana prepared years ago a book fitted to serve this purpose for the vicinity of New Haven; but even for that region there is need of a guide-book brought down to date, as regards both the scientific interpretation of phenomena and the arrangement of the itinerary. A series of such books for various districts of the state would make the study of geology in the high schools more real and genuine than it can otherwise be.

A report on the mineralogy of our state would be very useful. Lists of American localities of minerals have been published in a number of editions of the works of J. D. and E. S. Dana on mineralogy, the latest being in the sixth edition of the System of Mineralogy, published in 1892. A list of Connecticut minerals by Hattie E. Cochrane, dated 1894, is contained in the Report of the State Board of Education for 1896. Neither of these lists is by any means complete. Moreover, a report of the mineralogy of the state should be much more than a mere list of minerals occurring in the respective towns. Such a report should give more detailed information in regard to localities of interesting and important minerals, and should enter into some discussion of the geological relations of the minerals.

In the introductory chapter of the Manual of Connecticut Geology is found a brief discussion of the physical geography of the state in relation to geological structure. A subject whose treatment in a bulletin or in a series of bulletins would be of great educational value, would be the physical geography of various parts of the state, particularly in relation to human life and history. In such publications the influence of geographic conditions in the location of towns, in the determination of routes of travel, and in the control of the industries of the state, should be discussed. Such bulletin or bulletins on the physical geography of the state would be of great interest to all intelligent citizens, and particularly to the teachers in our schools.

### *II. Botany*

The labors of the Connecticut Botanical Society have given to us a list of the flowering plants of the state, and of the ferns and their allies. This paper affords much information in regard to the geographical and topographical distribution of particular species of plants. An appropriate line of investigation, and one in regard to which it may be hoped that the Survey may be able to publish important papers in the future, would be the more extended study of the distribution of plants with reference to altitude, geological formation, distance from the sea, temperature, and rainfall, and the grouping of plants into plant societies in different areas — in short, the study of what is now called the ecology of plants.

The systematic botany of the flowering plants has been comparatively well worked out for this region of country. Much less has been done in regard to the flowerless plants, and particularly in regard to the lower classes of flowerless plants. The paper of Professor Evans and Mr. Nichols on the mosses and liverworts, those of Professor White on the larger fungi, those of Dr. Clinton on the microscopic fungi, and that of Professor Conn and Mrs. Webster on the fresh-water algæ, are a good beginning in this direction. But there are a number of groups of the lower flowerless plants for whose study very little material is accessible to students or even to teachers in Connecticut. Interesting groups which should be treated in future bulletins of the Survey are the lichens and the marine algæ.

### *III. Zoölogy*

Professor Conn's paper on the protozoa makes a good beginning of the study of the life of our fresh waters. In future years attention should be given to other groups of fresh-water organisms; for instance, the mollusks, worms, crustacea, and fishes.

No general work dealing with the marine fauna of the Connecticut coast has been published since the very valuable paper by Verrill and Smith on the Invertebrate Animals of Vineyard

Sound, published in the Report of the United States Commissioner of Fish and Fisheries for 1871-2.* The State Survey has made a beginning of a series of papers on our marine fauna, in the paper of Professor Coe on the echinoderms, already accepted for publication, and the papers of Professor Verrill and Dr. Kunkel on the crustacea, which are expected to be finished and presented at an early date. Papers on the other groups of marine organisms should follow. Some of these papers would be of very great educational value, while some of them would be important from an economic point of view, since our marine fauna includes some species which are among the important resources of the state, and other species which are destructive of important resources.

Of the principal orders of insects, the Orthoptera are treated in a bulletin already in press, and the Hymenoptera in one which has been accepted for publication. A bulletin on the Hemiptera is in preparation. Other orders remain to be treated, among which are several of the most numerous in species and most important in economic relations.

A bulletin on the birds of Connecticut is soon to appear; but the mammals, reptiles, amphibia, and various groups of terrestrial invertebrates await consideration in future years.

### ALTERNATIVE PLANS

The plans outlined in the preceding paragraphs are for work substantially similar in character to the work which has been done in the previous years of the Survey. The value of such work is largely scientific and educational, though the economic side has been by no means ignored. Two projects, however, for work of more decidedly economic character are at present under consideration by the Commissioners, but have not yet been worked out so definitely as to enable the Commissioners to decide whether it is feasible or expedient to undertake either of them in the immediate future or not.

One of these is a soil survey of the state. Such surveys have been prosecuted in many of the states by the Bureau of Soils of the U. S. Department of Agriculture, while in other states such surveys have been conducted by Agricultural Experiment Stations or other local organizations. The Commissioners have not reached a positive conclusion on the question whether a soil survey of great utility to the agriculture of the state can be carried out without greater expenditure than is likely to be practicable in the near future.

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* Most of the animals living in Long Island Sound and Fisher's Island Sound are included in the fauna of Vineyard Sound.

The other project under consideration is a study of the water resources of the state, with a view to the practical question, what measures should be taken for the conservation of such resources. The threatened water famine in some of our large and growing cities emphasizes the importance of this question.

If either of these projects should be undertaken, there would be need of a decided increase of the appropriation for the Survey.

## THE NEED OF FURTHER APPROPRIATIONS.

What has already been said in regard to the work accomplished or in progress and the plans for future work, makes it obvious that the business of the State Geological and Natural History Survey is not rapidly approaching completion. In fact, the State Survey should be recognized as a permanent institution. The Geological Survey of the state of New York was commenced in 1836. There is at present no organization in the state of New York bearing the title of Geological Survey, but there is a State Geologist who is Director of the Science Division of the Education Department of the state, and on the staff of that Department are a State Botanist, a State Entomologist, and a number of other scientific workers. Under one form of organization or another, the work of investigation of the geology and natural history of New York under the auspices of the state has already been substantially continuous for more than two generations. There is no prospect that it will ever be finished.

In a number of states, indeed, Geological Surveys have been organized, prosecuted for a few years, and concluded by the publication of so-called final reports. But there can be no final report on the geology, the botany, or the zoölogy of any district of country. In those states whose Geological Surveys have published what have been called final reports, enlightened citizens and legislators have sooner or later come to see the necessity for organizing a second or third Survey and doing the work over again. The sciences of nature are progressive; new discoveries from time to time put old facts in new relations, and raise new questions whose answer requires new methods of investigation. There are changes also in the arts which depend upon the application of the sciences, as well as in the sciences themselves. New forms of raw material become valuable, new modes of utilizing well-known materials become practicable. On the economic side, as well as on the purely scientific side, arises a necessity that the work of a Survey which had been supposed to be completed should be done over again.

If a State Survey is recognized as a permanent bureau, it can publish, from time to time, supplementary reports correcting and amplifying its previous work as may be necessary. It can be ready also to give attention to particular investigations which may have a special importance, for economic or other reasons, at some particular time. Moreover, the work of a Geological and Natural History Survey can be carried on much more economically by the plan of small appropriations maintaining a permanent organization, than by the plan of attempting to complete the work in a few years and then doing it over again a generation later. The experience of our Connecticut Survey illustrates well the economy of this method of procedure. Field work can be done in the summer vacations by college professors, teachers, and others who are willing to do a certain amount of such work for very small compensation. Investigations can be made and bulletins can be written in large degree in odds and ends of time, by men who receive salaries for work in the colleges and schools or in museums and other scientific institutions. Under such conditions men of a high grade of ability and attainment are willing to offer for publication the result of their investigations for merely nominal compensation. The amount of valuable material already published, and the amount which is ready or nearly ready for publication, by our Survey, in comparison with the very small cost, is a striking illustration of the economy of this method of procedure. If, on the other hand, the work of a Survey is to be completed, and final reports presented in a few years, it is generally necessary that a number of competent men should be employed to give practically their whole time to the work. They must be paid salaries which will justify them in resigning any official positions which they may hold and taking their chances of securing other employment when the work of the Survey is finished.

The appropriation for the Connecticut Geological and Natural History Survey is one of the very smallest of those which are made by the states at present maintaining such surveys. North Dakota makes an appropriation somewhat smaller than that of Connecticut. Six states make annual appropriations for geology alone ranging from ten thousand to twenty-eight thousand dollars, exclusive of cost of publication, and five others make annual appropriations ranging from ten thousand to fifteen thousand dollars, inclusive of cost of publication. In comparison with an appropriation of ten thousand dollars for geology alone, our appropriation of fifteen hundred dollars for geology, botany, and zoölogy seems rather small. It is fair, however, to consider that Connecticut is not a large state, and that there is no probability that further geological exploration will develop great mineral wealth or create a great mining industry. If the work of the next few years is to be of the same general character as that of previous years, we are not disposed to urge strenuously a large increase of the appropriation. If, however, it should be deemed expedient, after further consideration, to undertake either a soil survey or a study of the water resources, there would be need, at least temporarily, of a very considerable increase of the appropriation. In any case we believe that the Survey should be recognized as having passed the experimental stage, and having vindicated its claim to be a permanent establishment. The present demand is for recognition as a permanent institution, and for adequate provision for the publication of the results of its work.

## LEGISLATION DESIRED IN REGARD TO PUBLICATION OF BULLETINS

The law establishing the Survey made it the duty of the Commissioners to cause to be prepared a report to the General Assembly before each meeting of the same, and special reports, with necessary illustrations and maps, on the geology and natural history of the state. It also made it the duty of the Commissioners to direct in regard to the sale or distribution of the reports, when printed. It imposed upon the Commissioners no responsibility for the printing. It was the obvious intent of the act that the whole of the small appropriation made for the Survey should be devoted to the scientific work of investigation and preparation of the reports. The cost of publication of the reports was to come out of the general funds in the treasury of the state. When the first bulletin of the Survey came to be printed, an unexpected difficulty appeared. The general law in regard to the state printing provides for the printing of not more than 1,575 copies of any public document, except certain reports in regard to which the law specifically provides for a larger edition. But an edition of 1,575 copies is utterly inadequate for the bulletins in the Survey. It is desired that these bulletins should be, as is customary in the case of similar publications in other states, widely distributed to colleges, scientific institutions, public libraries, scientific men, teachers, and others. The editions of similar reports published by other states generally range from 3,000 to 8,000. It is obviously useless to prepare elaborate scientific reports, and then print so small an edition as to render it impossible for those reports to reach the persons who would desire to use them. Hence the necessity for some action of the General Assembly to provide for the printing of the bulletins of the Survey.

The editions of bulletins thus far published have ranged between 3,000 and 4,000 copies. The former number seems the minimum number which will permit proper distribution of any of the bulletins likely to be published in the future. Some bulletins are of more popular character than others, and appeal to a wider constituency of readers.

The respective numbers of copies deemed necessary to meet the demand which may be reasonably anticipated in the case of the bulletins already accepted for publication but not yet ordered by the Board of Control to be printed, and of those bulletins which are approaching completion and which may be expected to be ready for publication within a few months, are shown in the following table: —

| Author | Subject | No. of Copies |
|---|---|---|
| F. P. Gulliver | Thames River Terraces | 3000 |
| H. E. Gregory | Glacial Geology of Naugatuck Valley | 3500 |
| C. A. Davis and others | Peat | 4000 |
| F. Ward | Glacial Geology of New Haven Region | 3000 |
| R. S. Harvey | Glacial Geology of Housatonic Basin | 3000 |
| R. S. Lull | Fossil Footprints | 3500 |

| Author | Subject | No. of Copies |
|---|---|---|
| G. P. Clinton | Downy Mildews | 3000 |
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| J. H. Sage and L. B. Bishop | Birds | 4500 |
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| B. W Kunkel | Amphipods and Isopods | 3000 |

It is needless to remark that the cost of the larger editions, in excess of the number of copies prescribed by the general law, is not great. In ordinary printing, the chief expense is in the composition, and that is the same for a small edition as for a large one. Where there are maps and illustrations, the largest item of cost is the preparation of the plates, and that too is independent of the size of the edition. The first nine of the scientific bulletins published by the Survey cost $9,570.90. On the basis of figures given by the printers it appears that the excess of cost above the 1,575 copies authorized by the general law was only about $3,033.

Reference has been made to the fact that the general law limiting the number of copies of public documents to 1,575, specifically provides for larger editions of the reports of certain officers and institutions. For instance, the maximum editions of certain reports, subject in each case to the approval of the Board of Control, are as follows: — state board of education, 6,000; bureau of vital statistics, 3,000; state librarian, 2,500; board of agriculture, 5,000; commissioners of fish and game, 3,000; bureau of labor statistics, 15,000; Connecticut agricultural experiment station, 12,000; state board of health, 3,000; factory inspector, 5,000; Storrs agricultural experiment station, 7,000; highway commissioner, 3,500. In each of these cases the Comptroller is authorized to print 575 additional copies for the bound volumes of public documents. It will be noticed that in general the reports of the scientific bureaus of the state are published in larger editions than the merely administrative reports of state officers, for the obvious reason that they should be read or consulted by a much larger number of people. It is obviously reasonable that the State Survey should be treated in the same manner as the other scientific bureaus.

In 1907 and again in 1909, the General Assembly authorized the printing of editions of the reports of the State Survey exceeding 1,575 copies during the ensuing biennial term, but accompanied that resolution by a resolution appropriating a specific sum for such publication, consequently limiting the amount of material which could be published. In the case of the other scientific bureaus above-mentioned, there is no such limitation. The publication of their reports, with the approval of the Board of Control, is made the duty of the Comptroller, and is paid for from the funds in the treasury without any specific appropriation.

We accordingly earnestly petition the General Assembly to amend the law in regard to the printing of public documents so as to authorize, in the case of the general and special reports of the State Survey, the printing of such numbers of copies as the Board of Control shall determine, not exceeding 4,500. The Board of Control can surely be trusted to guard against any extravagance. Such amendment would only carry out the intent of the act by which the Survey was established.

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# State of Connecticut

State Geological and Natural History Survey

BULLETIN No. 18

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# TRIASSIC FISHES
## OF CONNECTICUT

By

CHARLES ROCHESTER EASTMAN, Ph.D.

Professor of Paleontology at the University of Pittsburgh, and
Curator in charge of Fossil Fishes at the Carnegie Museum

# BULLETINS

OF THE

# State Geological and Natural History Survey of Connecticut.

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.
2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.
3. A preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.
4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.
5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.
6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.
7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory and Henry Hollister Robinson.
8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.
9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.
10. A preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn and Lucia Washburn (Hazen) Webster.
11. The Bryophytes of Connecticut: by Alexander William Evans and George Elwood Nichols.
12. Third Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1907-1908.
13. The Lithology of Connecticut: by Joseph Barrell and Gerald Francis Loughlin.
14. Catalogue of the Flowering Plants and Ferns of Connecticut growing without cultivation: by a Committee of the Connecticut Botanical Society. [Out of print.]
15. Second Report on the Hymeniales of Connecticut: by Edward Albert White.

16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part I. General Introduction: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

18. Triassic Fishes of Connecticut: by Charles Rochester Eastman.

Bulletins 1, 9, 12, and 17 are merely administrative reports, containing no scientific matter. The other bulletins may be classified as follows:

Geology: Bulletins 4, 6, 7, 8, 13, 18.
Botany: Bulletins 3, 5, 10, 11, 14, 15.
Zoölogy: Bulletins 2, 16.

These bulletins are sold and otherwise distributed by the State Librarian. Postage, when bulletins are sent by mail, is as follows: No. 1, $0.01; No. 2, .07; No. 3, .08; No. 4, .06; No. 5, .03; No. 6, .12; No. 7, .06; No. 8, .05; No. 9, .02; No. 10, .08; No. 11, 07; No. 12, .02; No. 13, .08; No. 14†; No. 15, .06; No. 16, .07; No. 17, .02; No. 18, .07. The prices when the bulletins are sold are as follows (including postage): No. 1, $0.05; No. 2, .35; No. 3, .40; No. 4, .30; No. 5, .15; No. 6, .50; No. 7, .60*; No. 8, .20; No. 9, .05; No. 10, .35; No. 11, .30; No. 12, .05; No. 13, .40; No. 14†; No. 15, .35; No. 16, .35; No. 17, .05; No. 18, .25.

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It is intended to follow a liberal policy in gratuitously distributing these publications to public libraries, colleges, and scientific institutions, and to scientific men, teachers, and others who require particular bulletins for their work, especially to those who are citizens of Connecticut.

Applications or inquiries should be addressed to

George S. Godard,
*State Librarian,*
Hartford, Conn.

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* If map is mounted as a wall map, and sent by express, $1.60.

† Bulletin No. 14 is out of print and can be furnished only in the bound volume.

# CATALOGUE SLIPS.

***Connecticut.*** *State geological and natural history survey.*

Bulletin No. 18. Triassic fishes of Connecticut. By C. R. Eastman. Hartford, 1911.

77 pp., 11 pls., 8 figs. $23^{cm}$.

***Eastman, Charles Rochester.***

Triassic fishes of Connecticut. By Charles Rochester Eastman, Hartford, 1911.

77 pp., 11 pls., 8 figs. $23^{cm}$.

(Bulletin no. 18, Connecticut geological and natural history survey.)

# CATALOGUE SLIPS.

***Geology.***

Eastman, C. R. Triassic fishes of Connecticut. Hartford, 1911.

77 pp., 11 pls., 8 figs. 23cm.

(Bulletin no. 18, Connecticut geological and natural history survey.)

***Paleontology.***

Eastman, C. R. Triassic fishes of Connecticut. Hartford, 1911.

77 pp., 11 pls., 8 figs. 23cm.

(Bulletin no. 18, Connecticut geological and natural history survey.)

# State of Connecticut.

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## BULLETIN No. 18

HARTFORD
Printed for the State Geological and Natural History Survey
1911

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# TRIASSIC FISHES
OF
# CONNECTICUT

By

CHARLES ROCHESTER EASTMAN, Ph.D.

Professor of Paleontology at the University of Pittsburgh, and Curator
in charge of Fossil Fishes at the Carnegie Museum

"Die Weisheit ist nur in der Wahrheit."—*Goethe.*

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1911

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# TRIASSIC FISHES OF CONNECTICUT.

## I.

## ON THE STUDY OF FOSSIL FISHES IN GENERAL.

> "There will we find laws which shall interpret,
> Through the simpler past, existing life."—
> *Kingsley.*

PALEONTOLOGY is the natural history of the Past. It is that branch of biological science which acquaints us with the endless succession of animate forms that has inhabited the earth since life first began. Primarily an extension of zoology and botany, as these subjects are commonly understood, it may be regarded also as an historical science, by virtue of the time element pervading it. Its aims and methods are akin to the historian's. The facts it deals with are vital facts, linked together by the principle of continuity and progressive development. The story it unfolds is one of world-wide changes, of silent, slow, and exceedingly gradual transformations wrought upon organic framework by an infinity of complex forces, strivings, tendencies, surroundings, all operating through immense cycles of time, and culminating finally in one supreme achievement — in the production of a race of beings possessed of self-conscious intelligence, and of a well-nigh unlimited development of that faculty.

The historical aspect of paleontology is worth considering. What is the theme of human history, if it be not the development of mankind? Is it not a record of all the changes in the state of men which have occurred since the first evidences of "the sons of men" upon our globe? Does it not, in a word, inform us of the *progression* of human events? The theme of paleontology is similar, but broader. It is compassed by, and at the same time extends, the domain of universal history. It treats of the development of life in general, considers it in its *grandes lignes,* in all its manifold manifestations. It is the record of all the changes and progressive modifications that have taken place among organic forms since their first appearance in remote geological antiquity. It seeks to ascertain the value of various adjustments to external conditions, of improvements in mechanical contrivances and other factors making for an advance; and, in tracing this line of progress, it aims to assign to different groups, or to different grades of the same group, their proper position and relative importance in the scheme of upward transformation.

If the mystery of the beginning of all things must forever remain insoluble for us, as Darwin with his life-work behind him was obliged to admit,[1] paleontology at least dispels for us some of the obscurity of former geological cycles, during which life existed on our planet and left memorials of its infinitely slow progress along the road to perfection. Perfection, that is, in the Darwinian sense: meaning the production of the higher animals, and their capacity for psychic advance. An impressive spectacle this; no one can contemplate it seriously without feeling the sense of that infinity in contrast with which a man recognizes his own finitude. Then it is that one feels in accord with Keats' view:

> "Stop and consider! life is but a day;
> A fragile dew-drop on its perilous way
> From a tree's summit; a poor Indian's sleep
> While his boat hastens to the monstrous steep
> Of Montmorenci. . . . "

It is not only a just, but a truly ennobling conception to regard paleontology as an extension of human history. *"La science des sciences, c'est donc la science de l'homme,"* Montaigne aptly remarks. Would we comprehend our own nature, and seek to know what man in his essence really is, what he has been, whence he came, whither bound, what destiny he may achieve, and, finally, what value attaches to his mortality — to acquire this self-knowledge we must study that larger nature of which man forms so insignificant a part. The soul grows in knowledge of itself as it realizes the contrast with the grandeur, the sheer massiveness of nature, and the eternity of the hidden forces which are now and ever have been at work re-shaping the world since the very foundation of being. Knowledge of this sort vastly enlarges our consciousness, gives to our mortality a setting and perspective, dilates the mind and elevates the spirit by forcing them to range widely over the realm of universal history. It also enables us to form a relative estimate of ourselves and our career by applying a larger scale of life — the scale of infinity. Clearly, therefore, the humanistic interest of paleontology is very great; and considerations of this nature help determine the value of any science quite apart from questions of practical utility. In every science there may be a twofold yield; one that is expressed in material values, and another that is interpreted in terms of the spirit. Returns of both kinds are worth striving for.

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[1] Life and Letters of Charles Darwin, edited by Francis Darwin.

But, it may be objected by some, the facts of paleontology can at best only remotely affect our traditional outlook upon life. For those who are satisfied merely with the assembling of facts, and look no further than a connection between them, without being able to comprehend the life of thought in general, this objection may hold. But the thoroughgoing inquirer insists not merely upon an accumulation of dead knowledge; his mind aims at an interpretation of the results of investigation, and attaches to these things meanings and values. So far as relates to human or universal history, the supreme value lies in *understanding* what has happened, in perceiving the meaning of events, in grasping the principles and laws that govern organic and social evolution. For this purpose the past must needs be reconstructed by means of the trained imagination out of all available data. The more vigilant the imagination, the better historian, and the better scientific investigator, other things being equal; for to the well-trained explorer in any science this faculty is never a hindrance, but a positive advantage. Obviously, if one lacks the power of transporting himself into the past, one can understand nothing of the past. But once that mental journey accomplished, and so soon as we acquire the habit of looking at experience objectively, without immediate relation to our own time and place, then, in the words of an English historian (Bury), "the modern age falls into line with its predecessors and loses its obtrusive prominence, and we come to see our petty periods *sub specie perennitatis.*" World-facts contemplated in this way help us, so says yet another historical writer (Villari), to "gain a new consciousness of our own being, and to win deeper insight into recesses of our own nature."

The essayist just quoted gives it as his opinion that the history of the whole universe is required to explain the individual man, "because," as he says, "more or less transformed, all history lives in us human beings. Therefore, as it lives in us all, why should we marvel at our power of transporting ourselves back into past times and living once more in them? In studying the history of Greece, we not only read the tale of a vanished past, but also that of a society and of a civilization that, although transformed, still endures within us as a constituent element of our mentality. Thus we are reading the history of a part of ourselves, and gain a clearer appreciation of that part on seeing it developed, magnified, and surrounded with its pristine glory, as it first flashed upon the world through the deeds of the Grecian people. . . . Thus in reading universal history we learn to recognize the process by which our own intelligence has been gradually built up. It has been justly remarked that, even as the geologist can trace the history of the transformations of the globe from any chance handful of earth, so too the philologist, on analyzing some phrase you have uttered, will find in it the record of the transformations of tongues."[1]

It is an obvious truism that to every man the world as he sees it depends on his physical organization and upon the way he has been taught to look at it through education and years of experience. But the scientific conception of the world and of the value and meaning of life has become profoundly modified within comparatively recent times through the influence of reorganizing ideas. Men in all ages have shown the keenest interest in the problems of man's origin and past development. The first great step in advance was made by the shores of the Ægean more than two thousand years ago. But the positive results of ancient philosophy were inadequate and limited, as compared with modern, because of its more limited resources. After the time of the Greek poets and philosophers, more than two milleniums were to pass away before those new reorganizing ideas — those which include the principle of continuity and the higher principle of development — became effectual in the world of thought, and enlightened mankind through the medium of Darwin's utterances. Both in history and in natural science the spirit of investigation was completely transformed by these ideas.

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[1] Villari, Pasquale, Studies Historical and Critical, 1907, p. 37 ff.

So much by way of parenthesis. Enough has now been said to show that the natural history of the past possesses rich interest from a culturo-historical or humanistic standpoint. And from these matters we pass on to a consideration of our special theme, the study of fossil fishes in general. Before speaking, however, of the introduction and succession of the class of fishes in point of chronological sequence, it may be useful to insert at this point a table showing the principal divisions of the stratigraphic column, which will serve the double purpose of indicating the position of our Triassic rocks in the system, and marking the advent of successively higher classes of vertebrates. Formational units, it is to be observed, are divided into systems, series, and groups; and the corresponding time-relations are expressed by the terms eras (or ages), periods, and epochs. Following is the commonly accepted arrangement:

GEOLOGICAL TIME-SCALE.

| Eras | Periods | Life |
|---|---|---|
| Cenozoic | Quaternary | Man |
| | Tertiary | Mammals the dominant class |
| Mesozoic | Cretaceous | Reptiles dominant throughout era |
| | Jurassic | Birds appear |
| | Triassic | Earliest mammals |
| Paleozoic | Carboniferous | Amphibians the dominant class |
| | Devonian | Fishes dominant |
| | Silurian | Invertebrates still dominant |
| | Ordovician | Fishes appear |
| | Cambrian | Leading groups of invertebrates |
| Archæan | | Scanty and indistinct organic remains |

The Cambrian system, at the base of the Paleozoic, has thus far failed to yield any indication of the presence of backboned creatures. Neither Chordates nor "Protochordates," that is, primitive forerunners of the vertebrate phylum, make their appearance in the geological time-scale until the Ordovician, after which they continue sparsely throughout the Silurian. From what lower group of organisms the primitive progenitors of the vertebrate stem were descended, and during what period the hiatus between diverse phyla was bridged over, we have no means of knowing. The absence of transitional forms, or indeed even of Protochordates, in strata anterior to the Ordovician is not a very significant fact, when it is considered that the primitive forerunners of chordate animals were probably soft-bodied, and therefore incapable of preservation in the rocks. Although numerous indications of fish-like vertebrates have been obtained at different localities both in this country and abroad, as, for instance, from the Ordovician of Colorado, Montana, and Scotland, it is not until the Silurian that their remains are found satisfactory enough for discussion. The dominant forms of fish life that we are acquainted with from rocks of this age belong to the lowly group of Ostracophores — creatures which differ from Fishes proper to such an extent that they are usually included in a separate class (Agnatha). They have incompletely formed jaws, are destitute of paired fins, and are without calcified endoskeletal parts (Fig. 1). On the other hand, as their name implies, they are protected by a shell-like external covering, whose elaboration can be traced through a number of successive stages. Toward the close of the Devonian they become entirely extinct, without leaving descendants.

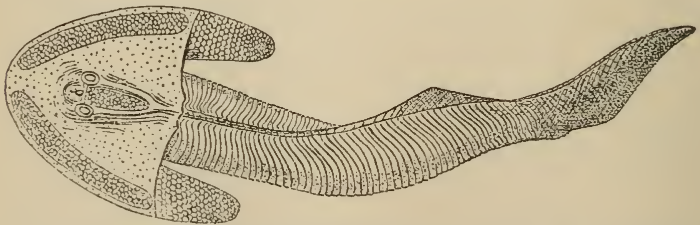

FIG. 1. *Cephalaspis murchisoni* Egerton. Lower Old Red Sandstone; Herefordshire. Head-shield seen from above, tail twisted to show dorsal fin and heterocercal tail mainly in side view. × ½ (after Smith Woodward).

Although forming the dominant feature of Silurian vertebrate life, Ostracophores are nevertheless accompanied in the

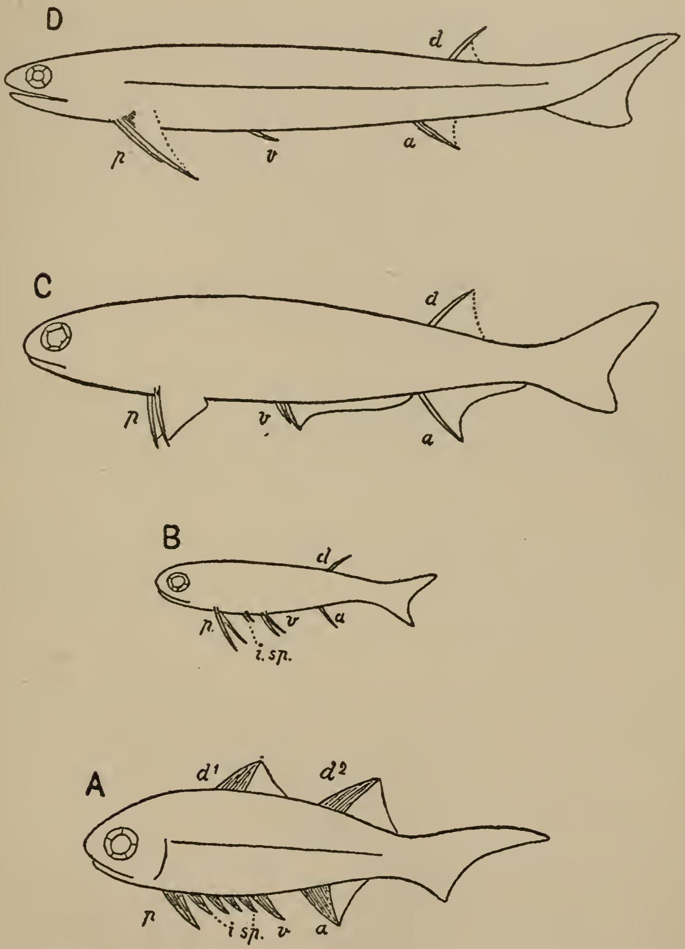

Fig 2. Outlines of Acanthodian Fishes, illustrating their gradual elongation in shape and loss of intermediate spines during successive periods. A, *Climatius scutiger* Egerton. Lower Old Red Sandstone; Scotland. B, *Mesacanthus mitchelli* (Egerton). *Ibid.* C, *Acanthodes sulcatus* Agassiz. Lower Carboniferous; Edinburgh. D, *Acanthodes gracilis.* Roemer. Lower Permian; Bohemia. *a*, anal fin; *d*, dorsal fin; *i. sp.*, intermediate spines; *p*, pectoral fins. (From Smith Woodward, partly after Traquair and Fritsch.)

latter part of that system by creatures which surpass them in grade, and are perfectly recognizable as true fishes, possessing as they do ordinary jaws and two pairs of lateral fins. These oldest remains of typical fishes — they are called Acanthodians after the name of the first described genus — are probably to be regarded as Elasmobranchs, and evidently have not diverged very far from the primordial stock which gave rise not only to the line of sharks and rays, but also to different grades of higher fishes. Acanthodians (Fig. 2) are a long-lived race, continuing throughout the Paleozoic. An allied primitive tribe that was less successful, and by reason of its long-bodied form is regarded by some writers (Woodward) as senile, is that typified by *Cladoselache* (Fig. 3), which is known from the late Devonian.

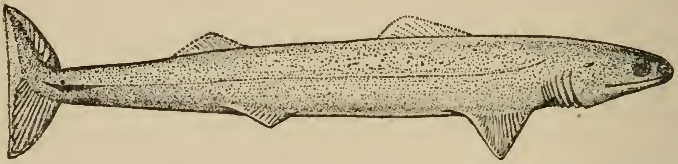

Fig. 3. *Cladoselache fylcri* Newberry. Cleveland shale (Upper Devonian); near Cleveland, Ohio. Right lateral aspect, about one-tenth natural size. A primitive shark, illustrating the simplest kind of paddle-fins, which are supported by nearly parallel bars of cartilage (after Bashford Dean).

During the Devonian appeared two large groups of fishes with paddle-shaped fins. These groups are commonly known as Lung-fishes and "fringe-finned" Ganoids — Dipnoi and Crossopterygii they are technically called. Their geological history is peculiar. Both groups early acquired dominance, spread over all regions of the globe, and seem indeed to have culminated in the Devonian, being numerically and specifically more abundant during that period than at any subsequent epoch. Only two modern survivors of Crossopterygii are known from African rivers (*Polypterus* and *Calamoichthys*). Of the long and archaic line of Lung-fishes represented by *Dipterus* (Fig. 4) and its associates in the Devonian, only the most generalized Ceratodont type, represented nowadays by but three fresh-water genera, has been able to persist until our own time. That the Ceratodont type has had a continuous existence since the early Paleozoic follows as a logical necessity from regarding the Dipterine group

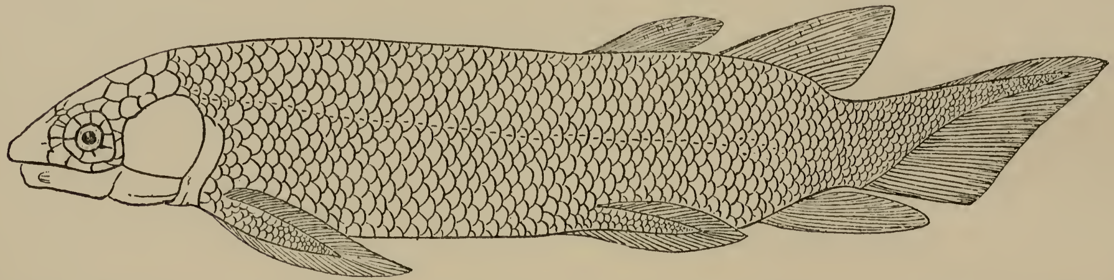

Fig. 4. Restoration of *Dipterus valenciennesi* from the Scottish Old Red Sandstone. × ½ (after Traquair).

as a specialized derivative. Recently described remains of *Protopterus* from the African Tertiary present an astonishing likeness to *Sagenodus,* as regards the dentition.

Yet another group of fishes, representing a still higher grade than any of the foregoing, makes its first appearance during the Devonian, but does not begin to acquire dominance until the Carboniferous. This is the great group of Actinopterygians or "ray-finned" fishes, to which by far the greater number of modern forms belong. From the Devonian onward until the close of the Permian, this higher grade of fishes was represented by a single family of primitive Chondrostei, whose degenerate descendants finally passed over into modern Sturgeons. It is probable that the short-lived family of the Catopteridæ, which gained a wide distribution in the Trias, is an offshoot of the tribe of primitive Sturgeons; and it is noteworthy that the decline of the latter began simultaneously with the rise of the next higher suborder, or Protospondyli. No links are known connecting this suborder with the Chondrostei, hence in the present state of our knowledge, the Sturgeon tribe and the Protospondyli are distinctly demarcated. During the Trias the Protospondyli are represented by the important and truly cosmopolitan family of Semionotidæ, which, with the previously mentioned Catopteridæ, form the chief constituents of our local Triassic fish fauna. The only modern representatives of this suborder are the bow-fin and garpike (*Amia* and *Lepidosteus*), both confined to the fresh waters of North America, and exhibiting the long-bodied shape of senile or decrepit derelicts.

Associated with members of the preceding suborder (Protospondyli) in rocks of the Upper Trias are found a few fishes having a remarkably modern aspect, and characterized not only by a complete vertebral column, but also by a simplified lower jaw, which consists of but two pieces on each side. The forerunners of the Isospondyli, as this suborder is called in allusion to the circumstance that the vertebræ are simple, without being fused into a group behind the head, scarcely differ in grade from the modern herring tribe. Among typical representatives may be mentioned the genera *Pholidophorus* and *Leptolepis,* ranging throughout the Triassic and Jurassic. The group displays rather feeble vigor until the beginning of the Cretaceous, when it rapidly multiplied, became dominant, and replaced the Protospondyli. Living members of the suborder belong to that division of bony fishes known as physostomous Teleostei.

One of the late Professor Beecher's generalizations, which seems to hold true throughout the animal kingdom, is that spines characterize only the latest representatives of the class. Applying this to the class of Pisces, Dr. Smith Woodward remarks: "The Acanthopterygii ("spine-finned") are thus the highest and latest fishes of all, though they sometimes eventually descend from their high estate by degeneration. They exhibit all the peculiar changes in the skull, upper jaw, and pelvic fins noticed as first appearing in a variable manner in the Cretaceous Isospondyli. The spiny-finned fishes began by Berycoids and possibly Scombroids in the Chalk, closely resembling, but not identical with genera living at the present day. By the Eocene period, however, nearly all the modern groups of Acanthopterygii had become completely separated and developed, and their sudden appearance is as mysterious as that of early Eocene mammals."

The same eminent authority also recapitulates the main outlines of the evolutionary history of fishes in the following passage:[1]

"Fossils prove that the earliest fish-like organisms strengthened their external armour so long as they remained comparatively sedentary; that next the most progressive members of the class began to acquire better powers of locomotion, and concentrated all their growth-energy on the elaboration of fins; that, after the perfection of these organs, the internal bony skeleton was completed at the sacrifice of the outer plates, because rapid movement necessitated a flexible body and rendered external armour less useful; that, finally, in the highest types the vertebræ and some of the fin-rays were reduced to a fixed and practically invariable number for each family and genus, while there was a remarkable development of spines. As survivors of most of these stages still exist, the changes in the soft parts which accompanied the successive advances in the skeleton can be inferred. Hence palæontology furnishes a sure basis for a natural classification in complete accord with the development of the group."

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[1] Woodward, A. S., The Relations of Palæontology to Biology. *Ann. Mag. Nat. Hist.*, 1906, ser. 7, xviii, p. 314.

Concerning the matter of classification, it need only be remarked that Pisces proper are divided into four subclasses, all of which have enjoyed a continuous history from the early Devonian onward to the present day. These subclasses are known under the following designations: (1) The Elasmobranchii, including modern sharks and rays; (2) Holocephali, or Chimæroids; (3) Dipnoi (Dipneusti), or Lung-fishes; and (4) Teleostomi, including ganoids and modern bony fishes. Only the last-named of these grand divisions is represented in the Triassic rocks of the Atlantic border region, and of the two orders embraced by it, the first (Crossopterygii) is represented by a solitary family and genus, and the second (Actinopterygii) by five genera belonging to three different families. The taxonomic relations of these families and genera are graphically illustrated in the following scheme: —

| SUBCLASS | ORDERS | SUBORDERS | FAMILIES AND GENERA |
|---|---|---|---|
| TELEOSTOMI | Crossopterygii | Actinistia | Cœlacanthidæ<br>1. *Diplurus* |
| | Actinopterygii | Chondrostei | Catopteridæ<br>2. *Catopterus*<br>3. *Dictyopyge* |
| | | Protospondyli | Semionotidæ<br>4. *Acentrophorus*<br>5. *Semionotus*<br>Eugnathidæ<br>6. *Ptycholepis* |

It will be seen from the foregoing table that the fauna with which we have to deal is relatively undiversified, and consists of surprisingly few elements as compared with contemporaneous fish faunas of other regions. The inference to be drawn is that these peculiarities are in all likelihood dependent upon the nature of the environment — that is to say, upon the absence of marine conditions over the area inhabited by this fauna. The evidence which compels us to regard the sediments in question as a non-marine facies of the Trias does not proceed primarily from the fossil fishes themselves. On the contrary, the North American species of *Semionotus, Ptycholepis,* and *Diplurus* are so closely affiliated with European "geminate types," to employ Jordan's term,[1] which occur in the marine Trias, that it is impossible to suppose that there were any great physiological differences between them. Hence there would be no reason in the absence of other evidence to believe that that they were adapted to a different habitat.[2].

While there is nothing in the character of the fossil fishes which would prove conclusively whether the deposits were formed in salt or brackish or fresh water, the physical character of the deposits and the fossils other than fishes found in them make it substantially certain that the deposits are not marine.[3] No corals, echinoderms, or brachiopods have been found in the Triassic in Connecticut or in any other of the Triassic basins of eastern North America. Mollusks are very few, and most of those found are undoubtedly fresh-water forms. A very few marine mollusks, it is claimed, have been found in the Triassic of Pennsylvania. A few crustacea, probably fresh-water or brackish-water forms, have been found in some of the southern Triassic basins, though not in Connecticut. A few insect larvæ have been found. For the rest the fossils of the formation consist of land plants and tracks of reptiles and amphibians, with a few skeletons of reptiles. Such an assemblage of fossils makes it clear that the formation is not marine, though the presence of a few marine shells (if those shells are rightly identified) indicate conditions in part estuarine.

Until recently the opinion has been generally held that the deposits of the Triassic of eastern North America were formed in tidal estuaries whose waters for the most part were brackish or nearly fresh. It seems probable, however, that the deposits were not formed in continuous water bodies coextensive with the areas occupied by the deposits; but that they include confluent alluvial fans formed by torrents descending from the mountain walls at the margin of the area, fluvial deposits formed by rivers migrating over the lowland, lacustrine deposits in places where the drainage was obstructed, with probably estuarine deposits in parts of the area that were covered by tidal waters, and very likely eolian deposits over parts that were dry land. Geologists have recently come to appreciate the importance of such "continental" deposits.[1]

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[1] Jordan, D. S., The Law of Geminate Species. *Am. Nat.,* 1908, xlii, pp. 73-80.

[2] De-Alessandri remarks as follows regarding the conditions under which the strata at Besano were deposited: "I caratteri litologici infatti dimostrano come i depositi costituenti la formazione raibliana di Besano debbono in parte ascriversi ad azione organica e che essi si costituivano poco lungi dalle coste. E l'esame della sua ittiofauna . . . . conferma appunto la natura costiera del giacimento."

[3] Rice and Gregory, Manual of the Geology of Connecticut, pp. 166-179 (State Geol. and Nat. Hist. Surv., Bull. 6.)

We have next to consider the question of the position occupied in the series of Triassic rocks by the fish-bearing beds in the local section, and also the ancillary query as to the contemporaneity of deposits in the Connecticut Valley and the New York-Virginia basin. For a solution of these problems extended comparisons are necessary with related faunas of other regions, wheresoever they may be found; and, as this phase of the discussion has received very little attention heretofore, we may be permitted to inquire into the matter somewhat fully. This will be the object of the following section.

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[1] J. V. Lewis, Origin and Relations of the Newark Rocks, pp. 102-108 (Geol. Surv. N. J., Ann. Rept. for 1906). W. M. Davis, The Triassic Formation of Connecticut, pp. 29-34 (18th Ann. Rept., U. S. Geol. Surv., Part ii). J. Barrell, Mud-cracks as a Criterion of Continental Sedimentation (*Journ. of Geol.*, xiv. pp. 524-568). In connection with these writings one may consult several recent articles by J. Lomas who interprets the British Trias as "filled-in desert lakes" (*Proc. Liverpool Geol. Soc.*, 1907, p. 183); also the Trias Reports of the British Assoc. Adv. Sci.; and Professor Bonney's paper On the Origin of the Trias (*Proc. Yorkshire Geol. Soc.*, 1906, xvi, p. 1).

## II.

## GEOLOGIC CORRELATION OF THE CONNECTICUT VALLEY FISH-BEARING BEDS.

The general consensus of opinion among geologists who have studied the Triassic rocks of eastern North America is that the sediments were deposited more or less contemporaneously in a number of isolated basins or troughs, these depressions occurring at intervals (rather than extending continuously) along the Atlantic border from Nova Scotia to South Carolina. As to the period of deposition represented by these sediments, in the opinion of the best authorities they are referred to the uppermost division of the Triassic system, that which in European geology is termed the Keuper. This opinion, be it observed, has rested hitherto almost exclusively upon the evidence of paleobotany. And not unnaturally, owing to the prevailing dearth of marine invertebrates, which always afford the most reliable indication of the age of strata.

In view of the almost total absence of the latter class of fossils, it is pointed out by Professors Rice and Gregory in their "Manual of the Geology of Connecticut" (p. 182), that the best paleontological evidence for purposes of correlation which is here available is that "afforded by comparison of the fossil plants, which occur abundantly in some areas of the formation, particularly in the Richmond area, with the fossil plants of some of the European strata." The results of such comparison show, as stated by these authors, "that the flora of these sandstones finds its nearest equivalent in that of the Keuper, the uppermost division of the European Trias. The indications afforded by the fishes and reptiles, though more scanty, are in harmony, so far as they go, with the evidence of the plants." In like manner Professor Lester F. Ward, writing in 1891, expressed the view that the flora of the New York-Virginia area fixes the horizon of the so-called "Newark formation" "with almost absolute certainty at the summit of the Triassic system, and narrows the discussion down chiefly to the verbal question whether it shall be called Rhaetic or Keuper. . . . . The beds that seem to be most nearly identical, so far as the plants are concerned, are those of Lunz, in Austria, and of Neue Welt, in Switzerland. These have been placed by the best European geologists in the Upper Keuper. Our American Trias can scarcely be lower than this, and it probably cannot be higher than the Rhaetic beds of Bavaria."[1]

Professor J. S. Newberry reached a similar conclusion in regard to the homotaxial relations of the "Newark" series of the Atlantic border region,[2] but it is rather singular that his reference of these beds to the uppermost Trias was based almost entirely upon the evidence furnished by fossil plants, whereas that afforded by the fishes was in part neglected, in part misinterpreted. This accomplished student of paleichthyology was clearly in error, as will presently appear, in supposing that the fishes of the Newark system are "not nearly related to those of any European formation," and he failed even to recognize the identity between the so-called *"Ischypterus"* of Egerton and Agassiz's genus *Semionotus*.

As early as 1850 Professor Louis Agassiz declared that in his opinion the fossil fishes from the Virginia coal field, and "from the so-called New Red Sandstone [of New Jersey and New England], indicate an age intermediate between the European New Red and the Oolite."[3] Subsequently he modified this view so far as to state that the fossils in question are the equivalent neither of the Triassic fishes of southern Germany, nor of those from the English Lias, wherefore he referred the

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[1] Ward, L. F., The Plant-bearing Deposits of the American Trias. *Bull. Geol. Soc. Am.*, 1891, iii, pp. 23-31.— Idem, Principles and Methods of Geologic Correlation by means of Fossil Plants. *Am. Geol.*, 1891, ix, pp. 34-47.

Writing three years earlier than Professor Ward, the Austrian geologist, D. Stur, concluded from the evidence of fossil plants that the Virginia coal-field area is the precise equivalent of the German Lettenkohle, which, according to some geologists, immediately underlies the Keuper, while by others it is regarded as the lowest division of the Keuper, just as the Rhaetic is sometimes incorporated with the Keuper as its uppermost member. The title of his paper is as follows: "Die Lunzer- (Lettenkohlen-) Flora in den 'older Mesozoic beds of the Coalfield of eastern Virginia.'" *Verh. Geol. Reichsanst.*, 1888, no. 10, pp. 203-217.

[2] Newberry, J. S., The Fauna and Flora of the Trias of New Jersey and the Connecticut Valley. *Trans. N. Y. Acad. Sci.*, 1887, vi, pp. 124-128.

[3] Agassiz, L., *Proc. Am. Assoc. Adv. Sci.*, 1850, iv, p. 276.

Newark rocks to a time interval between the Trias and Lias, for which there is no corresponding European expression.[1]

Most recently of all it has been claimed by the present writer,[2] in contrast to the views of Agassiz and Newberry, that the Newark fish fauna of the Atlantic border region does, in reality, manifest rather close relationship to those of certain European formations; and in particular that a marked correspondence exists between it and the assemblage that is known from the topmost member of the Alpine Muschelkalk — that is to say, the summital portion of the Middle Trias as developed in the Mediterranean region. The precise horizon from which the foreign assemblage in question has been obtained is the so-called Perledo limestone, on the eastern verge of Lake Como, in Lombardy, and usually correlated with the base of the Buchenstein beds.[3] By some authors the latter are referred to the base of the Ladinian, by others — and these would seem to be in the minority — to the summit of the Virglorian (zone of *Ceratites trinodosus*). Under these names, Ladinian and Virglorian, are understood respectively the upper and lower members of the Alpine Muschelkalk, where, as is well known, a threefold division such as characterizes the deposits of Germany north of the Alpine region is not observable.[4] The position of the Buchenstein limestone, and also of the higher (Keuper) fish-bearing beds of Besano, Raibl, Seefeld, etc., as compared with the Anglo-German Trias, is shown in the subjoined table. This is constructed more especially after the writings of Baron F. von Huene on the British, and those of Professors Haug, Arthaber and others on the Alpine Trias.[5]

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[1] Agassiz, L., *Proc. Am. Acad.*, 1852-57, iii, p. 69.

[2] *Geol. Surv. N. J.*, Ann. Rep. for 1904 (1905), pp. 70, 72.

[3] A convenient geological guide for the Como section will be found in chapter 1 of Dr A. Tornquist's "Führer durch das oberitalienische Seengebirge," forming volume 9 of the *Sammlung geologischer Führer* (Berlin, 1902).

[4] "Le Trias moyen comprend, comme on sait, deux étages: le Virglorien Ren. (= Recoarien Bittn., Anisien Mojs., Waag., Dien.), et le Ladinien Bittn."— E. Haug, in *Bull. Soc. Géol. France*, 1906, ser. 4, vi, p. 368.

[5] A generalized section of the Alpine Trias is given at page 254 of G. von Arthaber's treatise, incorporated with the second part of Frech's "Lethæa Geognostica" (Heft 2, 1905), and a more detailed section of the Como district at page 399 of the same work. Heft 1 of this volume contains an introduction, by the editor, to the study of the Mesozoic and Trias, and a description of the Continental Trias by E. Phillippi in collaboration with other authors (1903). See also the following by F. von Huene: "Eine Zusammenstellung über die englische Trias und das Alter ihrer Fossilien. *Centralbl. f. Mineral. Geol. Pal.*, 1908, pp. 9-17. A slightly different arrangement is indicated in the table given at p. 29 of G. De-Alessandri's memoir on the Triassic Fishes of Lombardy, 1910.

Correlation Scheme of Anglo-German and Alpine Trias.

| TRIAS | GREAT BRITAIN | GERMANY | ALPINE REGION |
|---|---|---|---|
| | Rhaetic | Rhaetic | Rhaetic |
| Upper | Keuper marl (Upper Keuper sandstone) | Upper<br>Middle } Keuper<br>Lower | Alpine Keuper { Hauptdolomit (Steinmergelkeuper)[1]<br>St. Cassian beds<br>Raibl beds (Salzkeuper)[2] |
| Middle | Lower Keuper sandstone | Lettenkohle | Wengen Beds |
| | | Upper<br>Middle } Muschelkalk<br>Lower | Ladinian (Buchenstein beds)[3]<br>Virglorian |
| Lower | Upper variegated sandstone<br>Pebble beds<br>Lower variegated sandstone (Bunter) | Upper<br>Middle } Buntsandstein<br>Lower | Werfenian (Werfen beds) |

Since the earlier studies of the Perledo fish fauna by Bellotti and Deecke, the relations of some of its component elements have been more accurately determined by different spcialists, with the result that it is now possible to make more exact comparisons between the Lombardy fauna and our own Triassic fauna. The following revised list of species, which agrees in the main with a similar one compiled by De-Alessandri, takes into account all of the published writings on Lombardy fish remains.

## Revised List of Triassic Fishes occurring in the Ladinian (Alpine Middle Trias) of Perledo, Lombardy.

### Crossopterygii.

Family Cœlacanthidæ.

1. *Heptanema paradoxum* Bellotti.

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[1] Fish-bearing localities of Seefeld, Tirol; Hallein, Salzburg; and Giffoni, Italy.

[2] Fish-bearing localities of Besano, Lombardy; and Raibl, Carinthia (Austria).

[3] Fish-bearing locality of Perledo, on Lake Como, Lombardy.

## Actinopterygii.

Family CATOPTERIDÆ.

2. *Perleidus altolepis* (Deecke).

Family BELONORHYNCHIDÆ.

3. *Belonorhynchus macrocephalus* Deecke (= *B. robustus* Bellotti MS.).

Family SEMIONOTIDÆ.

4. *Semionotus balsami* Bellotti.
5. *Colobodus* sp.
6. *Archæosemionotus connectens* Deecke.

Family MACROSEMIIDÆ.

7. *Ophiopsis lepturus* (Bellotti).
8. *Ophiopsis lariensis* De-Alessandri.

Family EUGNATHIDÆ.

9. *Eugnathus hermesii* (Bellotti).
10. *Eugnathus trotti* (Balsamo-Crivelli).
11. *Heterolepidotus pectoralis* (Bellotti).
12. *Heterolepidotus serratus* (Bellotti).
13. *Heterolepidotus taramellii* De-Alessandri.
14. *Heterolepidotus brevis* (Bellotti).
15. *Heterolepidotus* (?) *egidii-venantii* De-Alessandri.
16. *Heterolepidotus bellottii* De-Alessandri.
17. *Allolepidotus bellottii* (Rüppell).
18. *Allolepidotus nothosomoides* Deecke.[1]
19. *Allolepidotus rueppelli* (Bellotti).

Family PACHYCORMIDÆ.

20. *Urolepis macroptera* Bellotti.
21. *Urolepis microlepidota* Bellotti (including the so-called *U. elongata* Bellotti).

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[1] The status of Deecke's genus *Allolepidotus* is open to some question. By Gorjanovic-Kramberger it is regarded as a subgenus of *Heterolepidotus*. Compare this author's memoir on "Die obertriadische Fischfauna von Hallein in Salzburg" (*Beitr. Paläont. u. Geol.*, 1905, xviii, p. 212).

Family PHOLIDOPHORIDÆ.

21. *Pholidophorus curioni* (Heckel).
22. *Pholidophorus oblongus* Bellotti.
23. *Prohalecites porroi* (Bellotti).
24. *Pholidopleurus* sp.

Family LEPTOLEPIDÆ.

25. *Leptolepis* sp.

It will next be in order to present a list of the species composing the Triassic fish fauna of the Atlantic border region in this country, for the purpose of comparison with the above. In this list the names of those species occurring in the Connecticut Valley area are denoted by an asterisk.

## LIST OF FOSSIL FISHES OCCURRING IN THE "NEWARK" OR UPPER TRIASSIC ROCKS OF EASTERN NORTH AMERICA.

### Crossopterygii.

Family CŒLACANTHIDÆ.

1. *Diplurus longicaudatus* Newberry.

### Actinopterygii.

Family CATOPTERIDÆ.

2. **Catopterus gracilis* J. H. Redfield.
3. **Catopterus redfieldi* Egerton.
4. **Dictyopyge macrura* (W. C. Redfield).

Family SEMIONOTIDÆ.

5. **Acentrophorus chicopensis* Newberry.
6. **Semionotus agassizii* (W. C. Redfield).
7. *Semionotus brauni* (Newberry).
8. *Semionotus elegans* (Newberry).
9. **Semionotus fultus* (Agassiz).
10. *Semionotus gigas* (Newberry).
11. *Semionotus lineatus* (Newberry).
12. **Semionotus micropterus* (Newberry).
13. **Semionotus ovatus* (W. C. Redfield).

14. *Semionotus robustus* (Newberry).
15. **Semionotus tenuiceps* (Agassiz).

Family EUGNATHIDÆ.

16. **Ptycholepis marshi* Newberry.

On comparing the foregoing lists, it appears that both faunas — the Lombardy and the eastern North American — are made up exclusively of ganoids; and of these a single Crossopterygian family is represented in each case, while the remainder belong to the Actinopterygian order. Sharks and rays, Chimæroids and Lung-fishes, are conspicuously absent from both regions. Of the two families common to both provinces, of which *Semionotus* and *Catopterus* are representatives, the former is in each case the most important in point of numerical abundance, and is represented by the largest number of species. *Dictyopyge* is not common to both regions, nor conclusive as to age, since it ranges from the Bunter to the Upper Keuper in the Anglo-German Trias, and is known also from the Karoo formation of British South Africa and the Upper Trias of New South Wales. Two of the remaining genera of the American Trias are exceedingly rare in the Occidental region, each being represented by a solitary species. These are *Acentrophorus* and *Ptycholepis.* Of the former it is to be observed that it is apparently capable, despite its imperfect preservation, of being included in the same family as *Semionotus;* and as for the latter, of which only a few examples have been found at a single locality, near Durham, Connecticut, it is significant to note its occurrence at a slightly higher horizon in the Alpine Keuper (Besano and Raibl), where it is likewise accompanied by members of the Semionotidæ.

From the facts that have just been set forth one may infer that the so-called "Newark" fish fauna of this country is of more or less composite character, in that its chief constituents, or their analogues at least, are distributed between the middle (Ladinian) and upper (Keuper) divisions of the Alpine Trias. That a general correspondence exists between the Atlantic border fish fauna and that of the Middle Trias of Lombardy is now sufficiently evident; such relations as can be predicated between the former and various Keuper fish faunas of the Mediterranean region (southern and eastern Alps) will be apparent to students from the following tabulation.

### Fish Fauna of the Raibl Beds (Base of the Alpine Keuper) in Italy and Austria.

| Besano, Lombardy. | Raibl, Carinthia. |
|---|---|
| **Elasmobranchii.** | |
| 1. *Acrodus bicarinatus* Bassani. | |
| 2. *Hybodus* sp. ind. | **Crossopterygii.** |
| 3. *Nemacanthus tuberculatus* Bassani. | Family Cœlacanthidæ. |
| 4. *Leiacanthus pinii* Bassani. | 1. *Graphiurus callopterus* Kner. |
| 5. *Leptacanthus cornaliæ* Bellotti. | |
| **Actinopterygii.** | **Actinopterygii.** |
| Family Belonorhynchidæ. | Family Belonorhynchidæ. |
| 6. *Belonorhynchus curionii* (Bellotti). | 2. *Belonorhynchus striolatus* Bronn. |
| 7. *Belonorhynchus intermedius* Bassani. | 3. *Belonorhynchus* sp. (= *Teleosaurus tenuistriatus* Kner *errore*). |
| 8. *Belonorhynchus stoppanii* Bassani. | |
| 9. *Belonorhynchus striolatus* Bronn. | |
| Family Semionotidæ. | Family Semionotidæ. |
| 10. *Colobodus bassani* De-Alessandri. | 4. *Colobodus ornatus* Agassiz. |
| 11. *Colobodus varius* Giebel (= *Gyrolepis* sp. Bellotti MS. *fide* Bassani). | |
| 12. *Colobodus triasicus* (Bassani) (= *Lepidotus triasicus* Bassani). | |
| 13. *Allolepidotus* sp. ind. | |
| 14. *Dapedius* sp. ind. (= *Tetragonolepis* sp. Bassani). | |
| Family Macrosemiidæ. | Family Macrosemiidæ. |
| 15. *Ophiopsis bellotti* (Bassani) (= *Nothosomus bellotti* Bassani). | 5. *Orthurus sturii* Kner. |

| Besano, Lombardy. | Raibl, Carinthia. |
|---|---|
| Family Eugnathidæ. | Family Eugnathidæ. |
| 16. *Ptycholepis barboi* Bassani. | 6. *Ptycholepis avus* Kner. |
| 17. *Heterolepidotus gibbus* (Bassani) (= *Semionotus gibbus* Bassani *non* Seebach). | 7. *Ptycholepis tenuisquamata* Kner. |
| Family Pholidophoridæ. | Family Pholidophoridæ. |
| 18. *Pholidophorus barazzetti* Bassani. | 8. *Pholidophorus bronni* Kner. |
| 19. *Pholidophorus besanensis* Bassani. | 9. *Pholidopleurus typus* Bronn. |
| 20. *Pholidophorus cf. bronni* Kner. | 10. *Peltopleurus splendens* Kner. |
| 21. *Pholidophorus meridensis* De-Alessandri. | 11. *Peltopleurus* (?) *gracilis* Kner. |
| 22. *Pholidopleurus typus* Bronn. | 12. *Thoracopterus apus* Kner. |
| 23. *Peltopleurus splendens* Kner. | 13. *Thoracopterus niederristi* Bronn. |
| Family Pachycormidæ. | 14. *Prohalecites microlepidotus* (Kner). |
| 24. *Urolepis* sp. ind. | 15. *Megalopterus raiblianus* Kner. |

The above lists have been compiled chiefly from the writings of Kner[1] and Bassani,[2] and the more recent memoir of De-Allessandri (1910). These assemblages from the marine Keuper of southern Europe are instructive as showing the continued importance of the Semionotidæ, and their accompaniment by *Ptycholepis* and a single Crossopterygian genus different from either our own *Diplurus* or the unique *Heptanema* of Perledo.

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[1] Several articles on the fossil fishes from Raibl, contained in vols. 53, 55, and 56 of the *Sitzungsber. Akad. Wiss., Wien.*, 1866-67.

[2] Bassani, F., Sui fossili e sull'età degli schisti bituminosi triasici in Lombardia. *Atti della Soc. Ital. di Sci. Nat.*, 1886, xxix, pp. 15-72.

Compare also the lists given by Baron Achille de Zigno, in his "Pesci fossili di Lumezzane in Val Trompia (Lombardia)." *Mem. R. Accad. dei Lincei*, 1891, anno 287, p. 5. A comparative table of the Raibl and Lombardy section will be found at page 325 of Arthaber's work on the Alpine Trias, in Frech's "Lethæa Geognostica." For a history of previous attempts at a correlation of the Besano and Raibl faunas, see page 62 of Bassani's paper above cited.

*Catopterus* is indeed absent, but a possible offshoot from the ancient Palæoniscoids is found in the Pachycormid genus *Urolepis.*

Thus far we have been able to trace a certain similarity or at least a not remote correspondence, between our local "Newark" fish fauna and various assemblages belonging to the Upper Muschelkalk and Lower Keuper of the European marine Trias. Extending now the range of our comparison to a higher horizon, the fact cannot be gainsaid that there is in these later Mediterranean fish faunas appreciably less resemblance to that of the Atlantic border. The next higher horizon with which comparison of this nature is possible is the Hauptdolomit of various parts of Austria and Italy, a formation which is homotaxial with the Anglo-German Upper Keuper (Steinmergelkeuper), and is immediately succeeded by the Rhaetic. Everywhere in this later horizon, however, we meet with a more advanced expression of piscine evolution, and the character of the fauna acquires a decided Liassic aspect. We have, in fact, passed the limital division of the Keuper with which our "Newark" fish fauna can be most satisfactorily correlated, the ulterior bound being the Raibl beds of the Lower Keuper. This tends, therefore, to confirm the conclusion already put forward that the Triassic fish fauna of eastern North America is of more or less manifold nature, and corresponds in a general way to the interval between the uppermost Muschelkalk and the basal division of the Keuper in the Mediterranean region.

A tabulation of the Upper Keuper fish fauna of southern Europe is offered at this point by way of illustrating its more advanced grade in the scale of development. This has been compiled from both the older and more recent literature, including the writings of Kner,[1] Deecke,[2] de Zigno,[3] Bassani,[4]

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[1] Kner, R., Die fossilen Fische der Asphaltschiefer von Seefeld in Tirol. *Sitzungsber. Akad. Wiss. Wien.*, 1866, liv, pp. 303-334. Nachtrag. *Ibid.*, 1867, lvi, pt. 1, pp. 898-909.

[2] Deecke, W., Ueber Fische aus verschiedenen Horizonten der Trias. *Palaeontogr.* 1889, xxxv, pp. 97-138.

[3] De Zigno, A., Pesci fossili di Lumezzane in Val Trompia. *Mem. R. Accad. dei Lincei*, 1891, anno 287, pp. 1-10.

[4] Bassani, F., Sui fossili e sull' età degli schisti bituminosi di Monte Pettine presso Giffoni Valle Piana in Provincia Salerno (Dolomia principale). *Mem. della Soc. Ital. delle Sci.* (detta dei XL), 1893, ser. 3, ix, no. 3. *Idem,* La Ittiofauna della Dolomia principale di Giffoni (prov. di Salerno). *Palaeontogr. Italica,* 1895, i, pp. 169-210.—*Idem,* Elenco dei Pesci fossili degli schisti bituminosi triasici di Giffoni, nel Salernitano. *Rend. della R. Accad. delle Sci. di Napoli,* 16 Dec. 1899.

Gorjanovic-Kramberger,[1] De-Alessandri,[2] and others. The numerals indicate the number of species represented at the respective localities, which are as follows: Lumezzane, in Val Trompia, Lombardy; Seefeld, near Innsbruck, Tirol; Hallein, in Salzburg, Austria; and Giffoni, in the Province of Salerno, southern Italy.

COMPARATIVE TABLE OF HAUPTDOLOMIT FISH FAUNAS.

| Genera | Giffoni | Hallein | Seefeld | Lumezzane |
|---|---|---|---|---|
| **Crossopterygii** | | | | |
| Fam. CŒLACANTHIDÆ | | | | |
| 1. *Undina* | 1 | .. | .. | .. |
| **Actinopterygii** | | | | |
| Fam. BELONORHYNCHIDÆ | | | | |
| 2. *Belonorhynchus* | 1 | .. | 1 | .. |
| Fam. SEMIONOTIDÆ | | | | |
| 3. *Semionotus* | .. | 1 | .. | .. |
| 4. *Colobodus* | 2 | 2 | 2 | 2 |
| 5. *Heterolepidotus* | .. | 2 | 1 | .. |
| 6. *Dapedius* | 1 | 1 | 1 | .. |
| 7. *Spaniolepis* | .. | 1 | .. | .. |
| Fam. MACROSEMIIDÆ | | | | |
| 8. *Ophiopsis* | .. | 1 | .. | .. |
| 9. *Orthurus* | .. | .. | .. | 1 |
| Fam. PYCNODONTIDÆ | | | | |
| 10. *Mesodon* | .. | 1 | .. | .. |
| Fam. EUGNATHIDÆ | | | | |
| 11. *Eugnathus* | 1 | .. | 1 | .. |
| Fam. PHOLIDOPHORIDÆ | | | | |
| 12. *Pholidophorus* | 3 | 2 | 4 | 4 |
| 13. *Peltopleurus* | 1 | . | 1 | .. |
| 14. *Thoracopterus* | 1 | .. | .. | .. |
| Total number of species | 11 | 11 | 11 | 7 |

A final word may now be said concerning the relations between the Atlantic border or "Newark" fish fauna and the meagre indications of Triassic fish life that have been obtained from western North America. Owing to the well known intimate connection between the Upper Trias of California and that of southern Europe — the region which Neumayr years ago called the "central Mediterranean," and for which the name "Thetys" was proposed by Suess in 1894 — we might expect on purely *a priori* grounds to find a certain resemblance in the character of the vertebrate faunas of the two regions.[1]

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[1] Gorjanovič-Kramberger, K., Die obertriadische Fischfauna von Hallein in Salzburg. *Beitr. Paläont. Geol.* 1905, xviii, pp. 193-224.

[2] De-Alessandri, G., Studii sui Pesci Triasici della Lombardia. *Mem. della Soc. Ital. di Scienze Naturali e Museo Civico di Storia Nat. di Milano,* 1910, vii, pp. 1-148.

The scant evidence thus far obtained, however, at least as regards the fishes, fails to justify any such expectation. From the Lower Trias of Idaho have been described a single detached dermal spine, apparently belonging to *Asteracanthus*,[2] and a few fragmentary remains of Crossopterygii, which are possibly late survivals of Paleozoic families (Rhizodontidæ and Osteolepidæ).[3] Elasmobranchs and effete Crossopterygii persist even as late as the Upper Trias of Shasta county, California, where remains of *Hybodus, Acrodus, Holoptychius* and *Xenestes* have been brought to light, whose number, however, all told, makes an inconspicuous showing.[4]

Yet another sprinkling of ichthyic indications is known from the Red Beds of supposed Triassic age (Shinarump group) in southwestern Colorado and in the Kanab Canyon region of Utah and Arizona. Little has been published on the fossil vertebrate remains from this section,[5] but, so far as the fishes are concerned, it is clear that they display no intimate relations with those of the Atlantic border Trias. On the contrary, the general aspect of the Shinarump material suggests the foreshadowing of Jurassic conditions, and on that account the fauna announces itself as proemial, to employ Dr. Clarke's expressive term. The condition of the remains from the Kanab Canyon region is extremely fragmentary, and among them only the genus *Pholidophorus* and certain Lepidotidæ appear to be tolerably well indicated.

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[1] In regard to the invertebrate faunas, Dr. James Perrin Smith has the following: "The most interesting fact brought out by a comparison of the Upper Trias of California with that of India and the Alpine Mediterranean region is its near relationship with the latter, most genera and many species being common to the two regions. . . . This relationship of the Californian to the European faunas persists until after the middle of the Jurassic formation, when the Boreal fauna comes in."— *Journ. Geol.*, 1898, vi, p. 786.

[2] This is described under the name of *Cosmacanthus* by H. M. Evans, in *Bull. Dept. Geol. Univ. of Calif.*, 1904, iii, p. 397.

[3] Goddard, M., Fish Remains from the Marine Lower Trias of Aspen Ridge, Idaho. *Bull. Dept. Geol. Univ. of Calif.*, 1907, v, p. 145.

[4] Wemple, E. M., New Cestraciont teeth from the West American Triassic. *Bull. Geol. Dept. Univ. of Calif.*, 1906, v, no. 4, p. 73.— Jordan, D. S., The Fossil Fishes of California. *Ibid.*, 1907, v, no. 7, pp. 95-144.

[5] The chief literary references are collected by Dr. Whitman Cross in his article on "The Triassic Portion of the Shinarump Group, Powell," to be found in the *Journal of Geology*, 1908, xvi, pp. 97-123. See also the joint paper by the same author and E. Howe, entitled "Red Beds of Southwestern Colorado and their Correlation." *Bull. Geol. Soc. Am.*, 1905, xvi, pp. 447-486.

## III. GEOGRAPHY OF THE TRIAS.

> "It is the soul that sees: the outward eyes
> Present the object, but the mind descries."
> —*Longfellow.*

In this section it is not at all within our purpose to enter into an elaborate account of the physical conditions prevailing during the initial period of the Mesozoic, the theme being in itself an intricate one, and moreover, that phase of it which applies to our local section having been already sufficiently discussed. Such being the case, it will be sufficient merely to direct attention to a contribution pertinent to this topic, and one which contains perhaps the most comprehensive review that has been written on the faunal geography of the Upper Trias. We refer to the chapter on "The Seas of the Trias Era," by the late Professor E. Mojsisovics, Edler von Mojsvar, in his memoir on Triassic Cephalopods from the Himalayas,[1] wherein is collected practically all that is known of the distribution and relations of the invertebrate faunas of this era.

From this memoir, owing to its relevancy to the present discussion, we have ventured to extract a paragraph or two in regard to the principal regions of the "Central Mediterranean Sea" of Neumayr, or "Thetys" of Suess, from which Triassic faunas are known. So different from one another in character are these faunas that they are manifestly to be regarded as representing ancient geographic regions. These provinces are, in the language of their chief exponent and interpreter, as follows:

"1. Die Mediterranprovinz,
2. die germanische Flachsee, und
3. die indische Provinz."

Concerning the limits of these provinces the author remarks: "Die germanische Flachsee bildet eine Dependenz der Mediterranprovinz, und kann als ein grosses Aestuarium aufgefasst werden, welches dem ausgedehnten, heute im atlantischen Ocean versunkenen Continente vorgelagert war. Diese triadische 'Atlantis' existirte wahrscheinlich bereits am Schluss des paläozoischen Zeitalters.[1] Sie reichte im Westen vermuthlich bis zum heutigen Nordamerica,[2] welches bekanntlich auf seiner Osthälfte ausgedehnte triadische Binnensedimente vom Charakter des germanischen Buntsandsteines und Keupers besitzt, während pelagische Sedimente der Trias blos auf dem pacifischen Abhange dieses Continentes anzutreffen sind."

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[1] *Denkschr. k. k. Akad. Wiss.*, 1896, lxiii, p. 687.

Expressed in English, the meaning of the above paragraph would be that the second of these geographical provinces forms a restricted area of the first, and may be regarded as having formerly been a large estuary of an extensive land area now submerged beneath the Atlantic Ocean. This hypothetical Triassic continent, the so-called "Atlantis," probably became elevated above sea level at least as early as the close of the Paleozoic. It presumably extended westward to the present continent of North America, for along the eastern border of the latter are found non-marine Triassic deposits corresponding to the central European Buntsandstein and Keuper, while marine Triassic rocks occur only along the Pacific slope. [It is proper to point out that the theory of a submerged "Atlantis" is by no means universally held among modern geologists, but on the contrary many of the foremost authorities are firm believers in the permanence of continental land masses.]

To pursue this topic of paleogeography a step further, it is of interest to recall that the eastern and western boundaries of the Triassic Thetys are thus delineated by Professor James P. Smith, in his article on the "Classification of Marine Trias" (*Journ. of Geol.*, 1896, iv, p. 387):

"Along the western borders of Thetys were deposited the Triassic sediments of the Alps, Spain, southern Italy, the

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[1] Suess, Antlitz der Erde., ii, p. 317.

[2] Einen sicheren Anhaltspunkt für die Annahme eines solchen Continents bieten auch die Pflanzenreste dar, welche in den Kohlenfeldern des östlichen Virginiens gefunden und von Stur mit den Pflanzen des Lunzer Sandsteins (julische Stufe) identificirt wurden. Vergl. *Stur,* "Die Lunzer-(Lettenkohlen-) Flora in den 'older Mesozoic beds of the Coalfields of eastern Virginia.'" *Verh. Geol. Reichsanstalt,* 1888, p. 203.

Besides the paper of Stur's just referred to, one may consult the following by F. Zeller, which contains a comparison with the Alpine Trias: Beiträge zur Kenntniss der Lettenkohle und des Keupers in Schwaben. *Neues Jahrb. f. Mineral. u. s. w.*, Beilage-Bd. xxv, 1908, pp. 1-134. His correlation of the fish-bearing beds of the Alpine Trias is essentially the same as that adopted in the present Report.

Balearic Islands, Sicily, Hungary, and the Balkan Peninsula. This region was named by Mojsisovics the Mediterranean Trias province. Most of the faunas of the Trias, from near the base to the top, are represented in this region.

To the east the Thetys spread out to the waters of the Indian region, in which the sediments of the Himalayas and the Salt Range were accumulated. The Indian waters joined on the north, east and south with the great Arctic-Pacific Trias ocean, or Arctis of Mojsisovics, along the borders of which were deposited the sediments of northern and eastern Siberia, Spitzbergen, Japan, Rotti, New Zealand, New Caledonia, Peru and western North America. But in this ocean region there were many provinces as yet unknown, or only vaguely defined."

## IV. CONCERNING EARLIER INVESTIGATION OF NORTH AMERICAN TRIASSIC FISHES.

> "In den Wissenschaften ist es höchst verdienstlich, das unzulängliche Wahre, was die Alten schon besessen, aufzusuchen und weiter zu führen."
>
> — *Goethe.*

American vertebrate paleontology may be said to have begun with President Thomas Jefferson's description of fossil elephant remains from Virginia[1] in 1787, and the bones of *Megalonyx,* afterwards named *M. jeffersoni,* a dozen years later.[2] One has to turn back a little more than a century earlier, however, for the first published figure of an American fossil, this being *Ecphora quadricostata* from the Maryland Miocene.[3] The earliest records of all relating to the discovery of fossil vertebrate remains in the western hemisphere date from the time of Hernandez, court physician to Philip II, and other Spanish explorers of the seventeenth century.[4]

We cannot be sure when fossil fishes first began to attract attention in this country, but the earliest notices regarding them in any scientific publication fall within the second decade of the last century, and relate to remains discovered in the Connecticut Valley region. Several titles are comprised in these early notices, and among their authors occur such names as S. L. Mitchell, B. Silliman the elder, Edward Hitchcock, A. Brongniart, W. W. Mather, James E. Dekay, and others. *Per contra,* the occurrence of similar remains in the more southerly region does not seem to have become generally known until toward the middle of the nineteenth century. Those from the Virginia Coal fields were studied successively by the Redfields, father and son, Sir Charles Lyell, Sir Philip Grey Egerton, and Louis Agassiz; and a brief mention of fragmentary remains from North Carolina, accompanied by a few figures, was contributed by Ebenezer Emmons during the late fifties.

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[1] Notes on the State of Virginia. London, 1787.

[2] A Memoir on the Discovery of certain bones of a Quadruped of the clawed kind in the western parts of Virginia. *Trans. Amer. Phil. Soc.,* 1799, iv, pp. 246-260. Dr. O. P. Hay is authority for the statement that this work is said by C. G. Giebel to have been issued in 1797.

[3] Lister, M., Historia sive Synopsis Methodicæ Conchyliorum. London, 1685. Pl. 1059, fig. 2.

[4] References to old Spanish works in which these remains are attributed to a race of human giants are given in the second volumes respectively of Cuvier's "Ossemens Fossiles" and Humboldt's "Cosmos." The vulgar interpretation, which is apparently common to all primitive society, ancient and modern, finds an apt illustration in the Gigantomachia of classical antiquity. Consult the suggestive article by Dr. Th. Skouphos, in *Comptes rendus Cong. Inter. d'Arch.,* Athens, 1905, pp. 231-236. Also one by E. von Lasaulx on the Geology of the Greeks and the Romans, in *Abhandl. bayer. Akad. Wissensch.,* 1852, vi, pp. 517-566.

It is, however, to William C. and John H. Redfield, who wrote between 1837 and 1857, that we are indebted for the first really satisfactory account of the Triassic fish fauna of this country, these two having described nearly all the important species. Their results are embodied in ten publications, eight by the elder, and two by the younger author. These same pioneers also brought together an important collection, of which a good part is still preserved in the Peabody Museum at Yale University, and the rest is unfortunately destroyed or dissipated.

By far the most signal contribution to our knowledge of American Triassic fishes is that contained in Professor J. S. Newberry's "Monograph on the Fossil Fishes and Fossil Plants of New Jersey and the Connecticut Valley."[1] Several new species of *Semionotus* (described, however, under the title *Ischypterus*), *Ptycholepis* and *Diplurus* were established by him upon the evidence of tolerably satisfactory material, and one doubtful form was referred with some reservation to *Acentrophorus,* a genus that is otherwise limited, so far as known, to the Upper Permian. This elaborate work of Professor Newberry still remains our chief repository of information in regard to the particular subject before our consideration.

Since Newberry's time comparatively little has been added to our knowledge of the Newark fish fauna, except in the way of rectifying some minor details. An important memoir on the genus *Semionotus,* by Dr. E. Schellwien,[2] appeared in 1901, in which a few new anatomical points, accompanied by illustrations, are worked out for two previously known American species. A number of additional structural characters were made known in 1903 by Dr. George F. Eaton, of Yale University, in the case of four or five American species of *Semionotus*.[1] The diagnosis of this genus was further emended by Professor Gorjanovic-Kramberger, still more recently, in the course of his description of the Upper Triassic fish fauna of Hallein, Salzburg.[2] In this memoir the author set forth evidence intending to show that the family position of *Heterolepidotus* is with the Semionotidæ rather than with the Eugnathidæ, and that *Allolepidotus* of Deecke is identical with *Semionotus* proper.

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[1] *Monogr. U. S. Geol. Surv.,* xiv. Washington, 1888.

[2] Schellwien, E., Ueber Semionotus Ag. *Schriften der Phys.-Oekonom. Gesellsch. zu Königsberg i. Pr.,* 1901, pp. 1-34, pl. i-iii.

During the same year, 1905, some revised descriptions of the Triassic fishes of New Jersey were published by the present writer, with incidental mention of Connecticut Valley forms.[3] Reference was made in this paper to the totally different character of the Kanab Valley fish fauna (Triassic portion of the Shinarump group, Powell) as compared with that of the Atlantic border region, and it was pointed out that the former displayed a marked Liassic aspect. That the beds which carry this fauna are in reality anterior to the Lias, and probably belong to the late Trias, has been recently argued by Dr. Whitman Cross in the *Journal of Geology* for 1908. The few contributions that have appeared in regard to the Triassic fishes of the Cordilleran region have already been referred to in the preceding section.

In regard to restorations of the leading genera *Semionotus* and *Dictyopyge,* figures of these were published as early as 1864 by J. Struver, which are fairly accurate in respect to form of body and fin-structures, but leave much to be desired in the representation of cranial and facial bones. These figures are reproduced by Frech in his Introduction to the Mesozoic (Part II. of the "Lethæa Geognostica," Stuttgart, 1903), and two other illustrations of American Triassic fishes are copied in the same work from Newberry's Monograph (Texttafel vi, vii). No satisfactory restoration of *Catopterus* has yet appeared, but some figures of the head portion, prepared from original drawings by the late Professor Newberry, are now published for the first time in the present Report in the section devoted to that genus. (Figs. 5, 6, p. 54.)

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[1] Eaton, G. F., Notes on the Collection of Triassic Fishes at Yale. *Amer. Journ. Sci.,* 1903, ser. 4, xv, pp. 259-268, pl. v, vi.

[2] Gorjanovic-Kramberger, K., Die obertriadische Fischfauna von Hallein in Salzburg. *Beitr. zur Paläont. und Geol.,* 1905, xviii, pp. 193-224, pl. xvii-xxi.

[3] Geol. Surv. N. J., Ann. Rept. for 1904 (1905), pp. 67-102.

## V. SYSTEMATIC DESCRIPTIONS OF UPPER TRIASSIC FISHES.

"Die Natur ist das einzige Buch, das auf allen Blättern gewissen Inhalt bietet."—*Goethe.*

### Order **CROSSOPTERYGII.**

### Family CŒLACANTHIDÆ.

"Body deeply and irregularly fusiform, with cycloidal, deeply overlapping scales, more or less ornamented with ganoine. Branchiostegal apparatus consisting of an operculum on each side and a single pair of large jugular plates. Paired fins obtusely lobate. Two dorsal fins and a single anal; the anterior dorsal without baseosts, the posterior dorsal and the anal with baseosts, obtusely lobate. Axial skeleton extending to the extremity of the caudal fin, usually projecting and terminated by a small supplementary caudal fin. Air-bladder ossified."

As remarked by Smith Woodward, from whose Catalogue the foregoing definition has been taken, the members of this family have perhaps the most remarkable geological range of all known extinct fishes, persisting as they do practically unchanged from the Upper Devonian to the Upper Chalk. "The group is specialized," says this author, "in the large symmetrical caudal fin, which exhibits a series of supports directly apposed to the neural and hæmal arches, equalling in number both these and the overlapping dermal rays. It is also specialized in (i.) the fusion of the bones of the pterygo-quadrate arcade, (ii.) the reduction of the infradentaries to one, (iii.) the reduction of the opercular apparatus to the operculum on each side and a pair of gular plates, (iv.) the loss of the baseosts in the anterior dorsal fin, and (v.) the ossification of the air-bladder."

This family, first proposed by Louis Agassiz in the second volume of his "Poissons Fossiles" (1844, p. 168), and afterwards greatly restricted by Huxley in two important memoirs of the British Geological Survey (Decades X and XII, 1861 and 1866), is at present understood as comprising not more than six well recognized genera, among which the most satisfactorily known are *Cœlacanthus* proper, *Macropoma* and *Undina*. The typical genus enjoys the truly remarkable range from the Upper Devonian to the close of the Paleozoic, and, if the evidence of one or two doubtful forms be accepted, possibly even higher; the remaining genera extend throughout the Mesozoic, and exhibit such constancy of structural characters that the family has been frequently cited as one of the most distinct and well defined in the animal kingdom. Huxley, for instance, drew attention to its singular compactness and homogeneity in the following paragraph:[1]

"The Cœlacanthini, as thus understood, are no less distinctly separated from other fishes than they are closely united to one another. In the form and arrangement of their fins; the structure of the tail and that of the cranium; the form and number of the jugular plates; the dentition; the dorsal interspinous bones; the pelvic bones; the ossified air-bladder; the Cœlacanthini differ widely from either the Saurodipterini, the Glyptodipterini, or the Ctenodipterini; but, on the other hand, they agree with these families and differ from almost all other fishes, in the same respects as those in which the several families just mentioned have been shown to agree with one another, viz., the number of the dorsal fins, the location of the paired fins, the absence of branchiostegal rays and their replacement by jugular bones."

Finally, concerning the extraordinary conservatism and persistence manifested by the group of Cœlacanth fishes ever since its introduction, the illustrious English biologist whom we have quoted expresses himself as follows:[2]

"Bearing in mind the range of the Cœlacanths from the Carboniferous [since ascertained to extend from the Devonian] to the Chalk formation inclusive, the uniformity of organization of the group appears to be something wonderful. I have no evidence as to the structure of the base and side walls of the skull in *Cœlacanthus,* but the data collected in the present Decade shows that, in every other particular save the ornamentation of the fin-rays and scales, the organization of the Cœlacanths has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed "persistent types;" and, like the Labyrinthodonts, assist in bridging over the gap between the Palæozoic and the Mesozoic faunæ."

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[1] Huxley, T. H., Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch, prefixed to the Tenth Decade of the Figures and Descriptions illustrating British Organic Remains (1861, p. 20).

[2] Illustrations of the Structure of the Crossopterygian Ganoids. *Memoirs of the Geological Survey of the United Kingdom,* Decade xii, 1866. Reprinted in the supplementary volume of the Scientific Memoirs of Thomas Henry Huxley, 1903, p. 65.

The earliest known American representative of this family is a typical Cœlacanth, described as *Cœlacanthus welleri,*[1] from the Lower Kinderhook (base of the Mississippian series) of Iowa. Three other species are known from the Coal Measures of Ohio and Illinois, but none from later horizons until we meet with the very remarkable and in some respects degenerate (*e. g.*, as regards loss of certain of its head bones and most of its tail) *Diplurus* in the "Newark" rocks of the Atlantic border region. So far as known, this genus comprises but a single large species, *D. longicaudatus,* which is common to both the Connecticut Valley and New Jersey areas. A vicarious form, to use a German expression, or perhaps what President Jordan would call a "geminate species" or genus,[2] is represented in the Perledo limestone of Lombardy by *Heptanema paradoxum* Bellotti.

### Genus **Diplurus** Newberry.

Supplementary caudal fin prominent, with much elongated pedicle; fin-rays robust, closely articulated in the distal half; preaxial rays of the first dorsal and caudal fins with spinous tubercles. Scales and head bones irregularly striated, and some of the latter finely granulated.

### **Diplurus longicaudatus** Newberry.

1878. *Diplurus longicaudatus* J. S. Newberry, Ann. N. Y. Acad. Sci., i, p. 127.

1888. *Diplurus longicaudatus* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 74, pl. 20.

1891. *Diplurus longicaudatus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 2, p. 409.

1905. *Diplurus longicaudatus* C. R. Eastman, N. J. Geol. Surv. Rept. for 1904, p. 101.

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[1] *Journ. Geol.*, 1908, xvi, p. 357.

[2] Jordan, D. S., The law of geminate species. *Am. Nat.*, 1908, xlii, p. 73.

The type and only known species, attaining a total length of about 70 cm. to the tip of the supplementary caudal fin, and maximum depth of trunk about 20 cm. Anterior dorsal fin strong, supported by a single large laminar axonost; the lobate posterior dorsal nearly opposite the anal, and corresponding to it in form and size. Caudal fin much elongated, and separated from the supplementary caudal by a distinct interval. Paired fins obtusely lobate. Scales large, cycloidal, and deeply overlapping; the exposed portion marked with fine longitudinal rugæ; teeth unknown.

This large Crossopterygian is of extremely rare occurrence, being known by a scant half-dozen individuals, of which two, including the type, were obtained from near Boonton, New Jersey, and the others, very imperfect, from Durham, Connecticut. Most of the remains are now preserved in the American Museum of Natural History in New York, but there is one distorted example of the lower jaw in the Museum of Wesleyan University at Middletown (Cat. No. 846), which was collected by Mr. S. W. Loper from the anterior shales. Unfortunately this specimen shows no satisfactory indication of teeth, but appearances are at least suggestive that these were slender and conical. The external surface of the bone is finely granulated.

## Order **ACTINOPTERYGII.**

Paired fins non-lobate, having an extremely abbreviated endoskeletal portion, and the dermal rays prominent. Caudal fin abbreviate-diphycercal, heterocercal, or homocercal. A single paired series of transversely elongated rays, with or without an anterior azygous element, developed in the branchiostegal membrane between the mandibular rami.

### Suborder **CHONDROSTEI.** Sturgeons.

In these fishes, the oldest and most primitive of the Actinopterygii, the notochord is more or less persistent, the supports of the dorsal and anal fins are less numerous than the dermal rays apposed to them, the paired fins more abbreviate than in the Crossopterygian order, and the tail is completely heterocercal. Primitive sturgeons differ also from the fringe-finned ganoids in the development of a paired series of transversely elongated branchiostegal rays to replace the pair of jugular plates between the mandibular rami; infraclavicular plates, however, are retained in both groups. Nearly all the older forms have a well developed rhombic and ganoid squamation. So far as known, the chondrocranium is but little ossified, and the cranial bones are mainly dermal.

The evolutionary history of the sturgeon tribe is thus summarized by Professor Bridge in the Cambridge Natural History volume on Fishes (1904, p. 485):

"The Chondrostei are first represented in the Lower Devonian by the solitary Palæoniscid genus *Cheirolepis,* a contemporary of the earliest Crossopterygii. They occur throughout the Mesozoic period, except in the Cretaceous, and also in the Eocene, and, while steadily diminishing in number and variety, they gradually approximate to their degenerate and in some respects highly specialized descendants, the sturgeons and paddlefishes of the existing fish fauna. Of the seven families included in the group, the Palæoniscidæ are the oldest and most generalized. The Platysomatidæ are a specialized offshoot from the Palæoniscidæ, and, if they are rightly to be considered as Chondrostei, perhaps the same may be said of the problematic Belonorhynchidæ. On the other hand, there are certain features which indicate an approach to Fishes of an altogether more modern type. Finally, the Chondrostei represent a stage in a career of degeneration, the climax of which is reached by the modern Polyodontidæ and Acipenseridæ."

## Family CATOPTERIDÆ.

Trunk elongate or elongate-fusiform; tail abbreviate-heterocercal. Head bones well developed, ganoid; no median series of cranial roof-bones; teeth slender, conical; eye far forward, and snout prominent; mandibular suspensorium more or less obliquely directed backward and downward. A series of branchiostegal rays present. Dorsal fin single and not much extended. Scales rhombic, ganoid.

This short-lived family, in which are comprised not more than three closely related genera (*Catopterus, Perleidus,* and *Dictyopyge*), appears in the early Mesozoic just as the large and successful group of Palæoniscid fishes are entering upon their decline. Derived in all probability from the ancient Palæoniscid stock, and still retaining certain of its characteristics, these genera represent an advance over primitive sturgeons in the direction of the next higher suborder (Protospondyli), yet without marking a definite transition to that group. The upper lobe of the tail has become shortened, although still heterocercal; and in *Dictyopyge* at least the supports of the anal fin are recorded as fewer in number than the apposed dermal rays. The family is accompanied in the Trias by other Chondrosteans which became eel-shaped (Belonorhynchidæ) and died out during that period. Still others, which gradually lost their scaly covering and head bones (*Chondrosteus*), continued to survive, and are represented by the sturgeons of the present day. The relations of this family are, therefore, with modern sturgeons rather than with the two surviving genera of Protospondyli, *Amia* and *Lepidosteus.*

### Genus **Catopterus** Redfield.

(Syn. *Redfieldius* Hay.)

Trunk elegantly fusiform, head relatively small, tail hemi-heterocercal. External bones more or less ornamented with ridges and tubercles of ganoine; no median series of cranial roof-bones. Fins of moderate size, consisting of robust rays, more or less enameled, and distally bifurcated; fulcra well developed, short and closely set. Dorsal and anal fins triangular, the origin of the former behind that of the latter; caudal fin forked. Scales large or of moderate size, nearly or quite smooth, and serrated along their postero-inferior margin; dorsal ridge-scales not much enlarged. Teeth numerous, small, acutely conical.

This genus appears to be restricted to the Atlantic Border Trias of North America, although a supposed Catopterid genus, named *Perleidus* by De-Alessandri, occurs in the Ladinian limestone of Lombardy, and the still more closely related genus *Dictyopyge* is of world-wide distribution.

It is to be noted that remains of *Catopterus* are on the whole less abundant than those of the accompanying genus *Semionotus,* both in the Connecticut Valley area and in New Jersey, and as a rule they are less well preserved. Nevertheless, the characters presented by the former genus are so well marked and distinctive that there is seldom any difficulty in determining even the most fragmentary individuals. The most obvious peculiarity of the genus consists, as the name implies, in the remote position of the dorsal fin. In *Semionotus* the dorsal is always anterior to the anal fin, in *Catopterus* it is either opposite or posterior. The margins of all the fins are closely set with fine fulcra, in such wise that they present a delicately fringed appearance, and the fin-rays themselves are very numerous, finely articulated, and enameled. Other noticeable differences consist in the ornamented condition of the cranial bones, and serration of the hinder margin of the scales.

Whereas the genus *Semionotus* is represented in this country by half a dozen or more species, its associates *Catopterus* and *Dictyopyge* comprise a much smaller number, in fact not more than one or two each. After a critical study of differential characters we are forced to admit that only two species of *Catopterus* are capable of being clearly distinguished. These are *C. gracilis* Redfield and *C. redfieldi* Egerton, both founded on large and nearly complete fishes which differ from one another chiefly as regards proportions of body and scale characters. The so-called *C. parvulus* Redfield is probably to be regarded as the young of *C. gracilis,* and the species named by Newberry *C. minor* and *C. ornatus* are supposed to stand in a similar relation to *C. redfieldi.*

### **Catopterus gracilis** J. H. Redfield.

(Plates IX-XI.)

1837. *Catopterus gracilis* J. H. Redfield, Ann. Lyceum Nat. Hist. N. Y., iv, p. 37, pl. 1.

1841. *Catopterus gracilis* W. C. Redfield, Am. Journ. Sci., [1] xli, p. 27.

1841. *Catopterus gracilis* E. Hitchcock, Final Rept. Geol. Mass., ii, pp. 440, 460.

1888. *Catopterus gracilis* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 55, pl. 16, figs. 1-3.

1895. *Catopterus gracilis* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., iii, p. 2.

1905. *Catopterus gracilis* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 96.

The type species, attaining a total length of about 25 cm. Length of head with opercular apparatus about equal to maximum depth of trunk, and contained five times in the total length of the fish; depth of caudal pedicle somewhat less than one-half that of the abdominal region. Cranial bones finely granulated. Pelvic fins arising about midway between the pectorals and anal; dorsal and anal fins subequal in size, and almost completely opposed. Scales smooth, none deeper than broad, those of the flank in the abdominal region very finely serrated.

The fin-formula given for this species in the original description by J. H. Redfield is as follows:

D. 10-12; C. 30-40; A. 20-30; V. *circa* 8; P. 10-12.

In the additional notes on this form drawn up by the elder Redfield, it is stated that "the pectoral fins are of an elongated form, and are strengthened on the anterior margin by one or two large and partly flattened rays, to the front of which the fringe of fine raylets [fulcra] is attached. Owing to this peculiarity of structure, the smallest section of the pectoral fin will often serve to identify this species."

Although the form of body in this species is usually more slender than in *C. redfieldi,* it sometimes happens that distorted specimens, in which the anterior part of the trunk has become "shortened up" by mechanical deformation, simulate the deeper-bodied species in outline and general proportions. Conversely, also, the greater depth of body in *C. redfieldi* as compared with the genotype is often obscured by the familiar hazard of vertical compression, a circumstance which has frequently led to a confusion of the two species. Indeed, this very circumstance happens to be illustrated in the case of one of the original cotypes upon which the species was established by the younger Redfield; and so impressed was Newberry with the idea that the depth of body had become reduced by fortuitous agency that he actually proposed to cancel the specific name bestowed upon it by the original author, because, as he avers, for a fish which "in its normal condition has nearly the outline of the shad . . . the name of *Catopterus gracilis* is inappropriate and conveys a false impression."

Arbitrary and captious as Newberry's procedure appears to the modern systematist, such license was by no means uncommon, and, indeed, seems to have been not only tolerated but approved by the best paleontological authorities of his day. Nowadays, when nomenclatural codes are much more rigidly enforced, it would be contrary to all rule to abandon a valid specific name because of either a real or imaginary incongruity of meaning, and in cases where the name originally bestowed upon a species has become displaced for no more cogent reason than this, the tendency is to reinstate it. In the present instance it cannot be said that Newberry's proposal has become generally adopted, nor has it the sanction of long established usage; hence the only course open to us is to continue to recognize the original of Redfield's figure as one of the authentic cotypes of this species.

We are indebted to the generosity of Professor Schuchert for the privilege of reproducing a photograph of this well preserved exemplar (Plate IX), which is now the property of Yale University Museum. In this will be noted *inter alia* the Palæoniscid-shaped head, forwardly placed orbit, and tolerably distinct outlines of facial and cranial plates. The mandible, unfortunately, is missing, the striated opercular and tuberculated cheek plates are arranged after a different pattern from the corresponding parts in the Semionotidæ, and there is no clear indication of either a circumorbital ring or of branchiostegal rays.

Another nearly complete example of the same species is illustrated in Plate X. Like the first, it was obtained from near Durham, Connecticut, but from a somewhat higher level, the horizon being that known as the posterior shale.[1] Mr. S. W. Loper, who collected it, remarks that this is the only good specimen ever obtained from the beds in question, after many years of fruitless search. The specimen is remarkable for its well preserved squamation, and it also reveals the outline of the head much more satisfactorily than the Redfield cotype. The mandible is

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[1] Most of the fossil fishes in the Connecticut valley have been found at two well-marked horizons. One stratum of black shale lies between the lower (anterior, Percival) and the thick middle or main lava sheet, another between the main and the upper (posterior, Percival) lava sheet. These two fossiliferous strata have been called accordingly the anterior and the posterior black shale. Davis and Loper, Two Belts of Fossiliferous Black Shale in the Triassic Formation of Connecticut. *Bull. Geol. Soc. Am.*, ii, pp. 415-430.

Palæoniscid-like, and still carries a few minute teeth. Remains of the same species are common to both the New England and New Jersey areas.

### **Catopterus redfieldi** Egerton.

(Figs. 5, 6.)

1847. *Catopterus redfieldi* Sir P. G. Egerton, Quart. Journ. Geol. Soc., iii, p. 278.
1888. *Catopterus redfieldi* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 53, pl. 15, figs. 1-3.
1895. *Catopterus redfieldi* A. S. Woodward, Cat. Foss. Fishes Brit. Museum, pt. 3, p. 3.
1903. *Catopterus redfieldi,* F. Frech, Lethæa geognostica, Part 2, Trias, p. 12, text-pl. 7, fig. 2.
1905. *Catopterus redfieldi* C. R. Eastman, Ann. Rept. Geol. Surv. N. J. for 1904, p. 98.

This species is described by its founder as " broader than the preceding [*C. gracilis*], and with scales not so long in proportion to their depth." The original definition has been supplemented by a number of differential characters observed by Newberry, and the extended description given by the American author has been condensed by Smith Woodward into the following paragraph:

"A comparatively robust species as large as the type. Length of head with opercular apparatus not more than two-thirds as great as the maximum depth of the trunk, and contained nearly six times in the total length of the fish; depth of caudal pedicle equaling about one-third that of the abdominal region. Cranial bones finely granulated. Pelvic fins arising midway between the pectorals and anal; dorsal and anal fins nearly equal in size, and the former arising opposite to the middle of the latter. Scales mostly smooth, but sometimes in part longitudinally striated, the striæ terminating in the coarse serrations of the posterior border which characterize the principal flank-scales; many of the flank-scales deeper than broad."

Neither in this nor in any other species of *Catopterus* has the structure of the head and shoulder-girdle been satisfactorily worked out, these parts being as a rule too imperfectly preserved for study. Nevertheless, an attempt was made in this direction by J. S. Newberry, and it is perhaps worthy of note that the material upon which his restorations were based, together with certain unpublished figures and manuscript notes, are now the property of the American Museum of Natural History. For the privilege of studying both the original material and the records of Newberry's interpretation of them, the writer is indebted to the courtesy of his friend Dr. Bashford Dean, Curator of fossil fishes in the American Museum of Natural History in New York. With his permission, two of Newberry's original drawings are reproduced for the first time in Figs. 5 and 6, one representing the head portion viewed from above and to one side, the other from below.

With reference to the specimens serving as the basis of Newberry's restorations it may be remarked that the larger and more perfect (the one shown in Fig. 5, Cat. No. 2431) has the head portion preserved in the form of an impression, wherein certain sutural indications are plainly visible, others less clearly so. Three drawings of this specimen occur among Newberry's reliquiæ, all bearing explanatory legends in his handwriting. From a careful collation of these with the original it appears that our author was mistaken in his reading of several parts of the cranial osteology, more particularly as regards the cheek plates and opercular apparatus, and it is a question whether he has not sometimes mistaken grooves of the sensory canal system for suture lines.

But at the same time it must be admitted that precisely in these particulars, owing to lack of definiteness in the impression, there is room for considerable latitude of interpretation, and that after all a final judgment cannot be based upon this single specimen standing alone, without the aid of well authenticated points of control derived from comparison of a large quantity of material. No single specimen has yet come to light which reveals the lateral aspect of the head in thoroughly satisfactory manner, and any attempt to correct or improve upon Newberry's restoration must proceed from a mosaic built up of overlapping sections. Much effort has been expended by the present writer in this direction, and some progress has been made towards elaborating the complete cranial structure. Yet the work is still incomplete, and, owing to deficiency of reliable material, the time has not yet come when a thoroughly satisfactory and authentic restoration can be given of the head. For the present, however, we may content ourselves with calling attention to the general Palæoniscid-like arrangement of the cranial plates, as far as the details have been worked out; and, in default of a tentative figure showing these parts, we may refer the reader to the different types portrayed in Fig. 7 on page 59, with special emphasis upon the approach made by *Catopterus* to the early and more primitive models.

A few words may be said in regard to the second of Newberry's drawings, which has this in common with the first, and indeed with all pioneer studies; that, however we may judge of its accuracy, it is at least an interesting historical document, and has a certain intrinsic value in so far as it acquaints us with a graphic presentation of the author's views at the stage he had then attained in his investigations. In Fig. 6 is represented Professor Newberry's idea of the structure of the under side of the head. A comparison of his drawing with the original specimen (Cat. No. 635 G) shows that the head is much distorted, the clavicle and infraclavicle being displaced far forwards, and thereby producing a very deceptive appearance. It may be stated positively that no median jugular plate is present, nor is any trace to be seen of the branchiostegal apparatus. The space included within the angle formed by the mandibular rami appears to have been covered in part by rhombic ganoid scales, in part by indurated skin ornamented with papillæ, but not occupied by distinct plates. Both of Newberry's originals were obtained from near Durham, Connecticut.

By way of summarizing the few definitely known facts that have been gleaned from a comparison of very numerous cranial fragments belonging to this species, the following points may be noted: The head is in general Palæoniscid-like. There is a pair of small parietals behind, in front of which are placed the narrow and elongate frontals, traversed longitudinally by sensory canals; and these are succeeded in turn by a median ethmoid of the form shown in Newberry's drawing (Fig. 5, *e*). This median system of plates is bounded on either side by three pairs of lateral plates which may be designated as the squamosal, postfrontal, and prefrontal. There is no circumorbital ring, and the suborbitals are apparently few in number. The preoperculum is inconspicuous, and the posteriorly enlarged maxillary resembles or at least suggests in form that of Paleozoic Chondrostei. It is beset with numerous fine, acutely conical teeth, and there is also a small dentigerous premaxilla which is often preserved in the dissociated state.

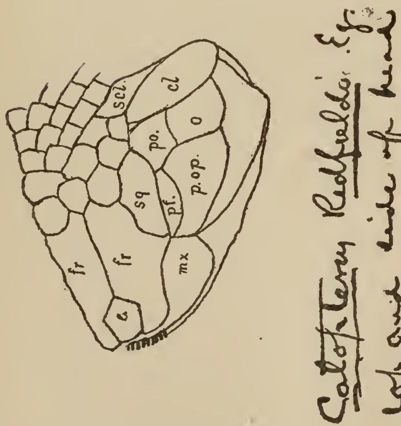
Catopterus Redfieldi' Eg.
top and side of head
fr
fr
e
mx
sq
pf.
p.op.
po.
o
scl.
cl

Fig. 5. *Catopterus redfieldi* Egerton. Trias; Durham, Connecticut. Reproduction of Newberry's original drawing (with manuscript legend), showing dorso-lateral aspect of the head, based upon a specimen preserved in the American Museum of Natural History, New York (Cat. No. 2431). × 1/1. *e*, ethmoid; *fr*, frontal; *mx*, maxillary; *sq*, squamosal; *pf*, postfrontal; *po*, (?); *p. op*, preoperculum; *o*, operculum; *cl*, clavicular scale; *scl*, supraclavicle.

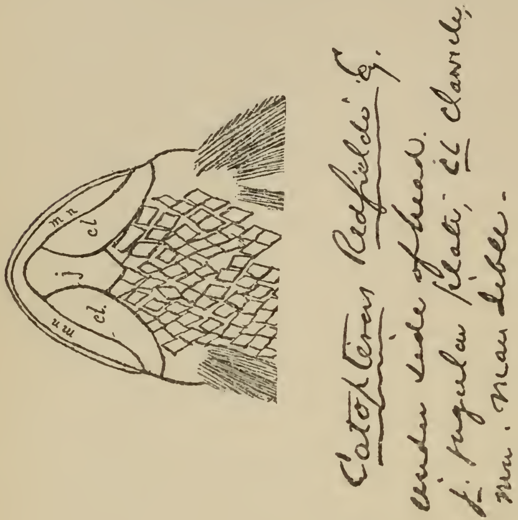
Catopterus Redfieldi' Eg.
under side of head.
j. jugular plate; cl clavicle;
mn. mandible.
mn
cl.
j
cl
mn

Fig. 6. *Catopterus redfieldi* Egerton. Trias; Durham, Connecticut. Reproduction of Newberry's original drawing (with manuscript legend), showing under side of the head, based upon a specimen preserved in the American Museum of Natural History, New York. × 1/1. *cl*, clavicle; *j*, jugular (so-called); *mn*, mandible.

The distribution of *C. redfieldi* is identical with that of the type species, and, like the latter, it is more abundant at Durham than in any other locality.

Besides the two species we have just noticed, names have been proposed for several others whose status is very uncertain. Some are doubtless to be regarded as young individuals belonging to one or the other of the above characterized forms, and the types upon which others are founded defy adequate description. In the opinion of Smith Woodward, as remarked by him in Part III of his "Catalogue of Fossil Fishes," the so-called *Catopterus minor* Newberry is probably founded on immature and variously distorted examples of *C. redfieldi*. Further, the same author regards it as uncertain whether the type of *C. ornatus* Newberry should be associated with this species or some other. "The type," he says, "is a unique, much distorted, small specimen from Durham, which seems to have been chemically eroded in such a way as to display the concentric lines of growth in the scales" (*loc. cit.*, p. 3). It should be said with reference to this last statement that the concentric markings of the scales, which seem to be correlated with a subovate form of the latter, are to be seen only along a part of the flank, where the body has been much twisted upon itself. They fail to show in the impression which is visible of the opposite side of the body; and these two facts taken together tend to strengthen the belief that they are of accidental origin.

### Genus **Dictyopyge** Egerton.

Distinguished from *Catopterus* only by the more anterior position of the dorsal fin, which never arises behind the origin of the anal.

### **Dictyopyge macrura** W. C. Redfield.

1841. *Catopterus macrurus* W. C. Redfield, Am. Journ. Sci., [1] xli, p. 27.
1847. *Dictyopyge macrura* Sir P. G. Egerton, Quart. Journ. Geol. Soc., iii, p. 276, pl. 8; pl. 9, fig. 1.
1857. *Catopterus macrurus* W. C. Redfield, Proc. Amer. Assoc. Adv. Sci. 1856, pt. 2, p. 186.
1888. *Dictyopyge macrura* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 64, pl. 18, figs. 1, 2.
1895. *Dictyopyge macrura* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 3, p. 4, fig. 1.

1905. *Dictyopyge macrura* C. R. Eastman, Ann. Rept. Geol. Surv. N. J. for 1904, p. 99, pl. 13.[1]

A species attaining a total length of about 15cm. Length of head with opercular apparatus somewhat less than the maximum depth of the trunk, and contained nearly five times in the total length of the fish; depth of caudal pedicle less than one-half of that of the abdominal region. Cranial bones externally ornamented with fine granulations. Pelvic fins arising midway between the pectorals and anal fin; dorsal at least as high as long, arising slightly in advance of the anal, and nearly as large as the latter; anal with about 30 rays, and extending almost to the base of the caudal fin. Scales smooth, not serrated.

This, the type species of the genus, was originally described under the name of *Catopterus macrurus,* but was afterwards held by Sir Philip Grey Egerton to be excluded from association with the latter genus on account of the following differential characters: (1) "the dorsal fin is more strictly opposite to the anal than in *Catopterus redfieldi;*" and (2) "having a homocercal tail, it cannot be comprehended in it." It was pointed out by the elder Redfield, however, who denied that *Dictyopyge* was entitled to rank as an independent genus, that the type species was in reality no less heterocercal than other Catopteridæ, and "with the other common characters the slight difference in the position of the fins had in his judgment only a specific value." The close resemblance between the two genera, *Catopterus* and *Dictyopyge,* was also remarked by Newberry, who observes: "The only differences which I can specify between our commonest species of *Catopterus* and *Dictyopyge* are the broader operculum, the narrower scales of the belly, and the less deeply forked tail of the latter."

This species occurs typically in the Upper Trias of the Virginia Coal field, and its presence has not previously been reported elsewhere. There is, however, in the collection belonging to the Museum of Comparative Zoology at Cambridge a single specimen (Cat. No. 2531), labelled as having been derived "probably from Middletown, Connecticut," and erroneously referred in the above-cited publication to the type species of *Catopterus.* Regarded as a young individual of that species, it was figured under that name by the present writer in the Report of the State Geologist of New Jersey for 1904. A reconsideration of its characters, however, especially the remote position of the dorsal fin, and the appearance of the squamation and opercular plates, leaves little room to doubt that its affinities are with *Dictyopyge.* Nor does any good reason appear for doubting the trustworthiness of the record of the locality whence the specimen was derived. The micaceous grains in the matrix are a characteristic feature of the Connecticut Valley sandstone, and the general appearance of the rock is wholly dissimilar to the prevailing type of deposit occurring either in New Jersey or Virginia. For the present, therefore, the evidence of this specimen must be accepted as proving the presence of *Dictyopyge* in the Connecticut Valley area.

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[1] The original of this plate is here incorrectly assigned to *Catopterus.*

### Suborder **PROTOSPONDYLI.**

In this suborder, as distinguished from Paleozoic and early Mesozoic Chondrosteans, the median fins become absolutely complete, in that each separate ray has its own individual support. At the same time the upper lobe of the tail is considerably shortened, so that the caudal fin forms a flexible fan-shaped expansion at the blunt end of the body. The members of this suborder chiefly characterize the Triassic and Jurassic periods, and exhibit endless variety; but their sole survivors at the present day are the long-bodied garpike (*Lepidosteus*) and bowfin (*Amia*) of American fresh waters.

### Family SEMIONOTIDÆ.

Trunk more or less deeply fusiform, rarely cycloidal. Cranial and facial bones more or less robust, and opercular apparatus complete. Gape of mouth small, teeth styliform or modified for crushing. Notochord persistent, vertebræ not more than rings. Fin-rays robust, fulcra large, dorsal fin not extending more than one-half the length of the trunk. Scales rhombic, except occasionally in the caudal region.

### Genus **Semionotus** Agassiz.

(Syn. *Ischypterus* Egerton.)

Trunk fusiform. Marginal teeth slender, conical, somewhat spaced, inner teeth stouter; opercular apparatus well developed, with a narrow arched preoperculum. Ribs ossified. Fulcra unusually large. Paired fins small, dorsal fin large, arising at or behind the middle of the back, and in part opposed to the relatively small anal; caudal fin slightly forked. Scales smooth or feebly ornamented, and the narrow overlapped margin produced at the angles and at the superior border. Flank-scales not more than twice as deep as broad, the dorsal ridge-series of acuminate scales forming a prominent crest. (Woodward.)

The cranial osteology of this genus is much more satisfactorily known than that of *Catopterus,* although information is still lacking in some particulars. The researches of Agassiz acquainted us in a general way with the structure of the head portion in *S. nilssoni,* from the Rhaetic of Sweden (see Plate VI), and in recent years our knowledge has been increased by the studies of E. Schellwien, Stromer, Tornquist, and other foreign writers, and by the careful work of Dr. George F. Eaton of Yale in this country. Principal enlightenment has been gained from investigation of *S. nilssoni, bergeri, capensis* and *agassizii.* The more important cranial features may be briefly indicated as follows:

The membrane bones of the cranial roof form a continuous shield, extending from the snout nearly to the occipital border. The two principal pairs of bones are the narrow and elongate frontals, reaching from the premaxillaries to behind the orbits, and the much shorter parietals in contact with them posteriorly. As a rule these pairs are not quite bilaterally symmetrical, but the sutures are more regular than in some other members of the same family. Skirting the lateral borders of the frontals, and extending also over the forward part of the parietals, are deep mucous canals, which are developed on the cerebral side of the bones, and hence not commonly visible in the outer aspect. Behind the parietals occur a pair of wedge-shaped plates corresponding to the supratemporals of Palæoniscoids. These are followed in turn by the squamose posttemporals, which in most species resemble the like-named parts in primitive Chondrosteans.

The squamosal is a plate of variable width and irregular shape abutting against the parietals and frontals. It is terminated anteriorly by a ring of circumorbitals, but its posterior limits are apparently not the same for all species. The circumorbitals,

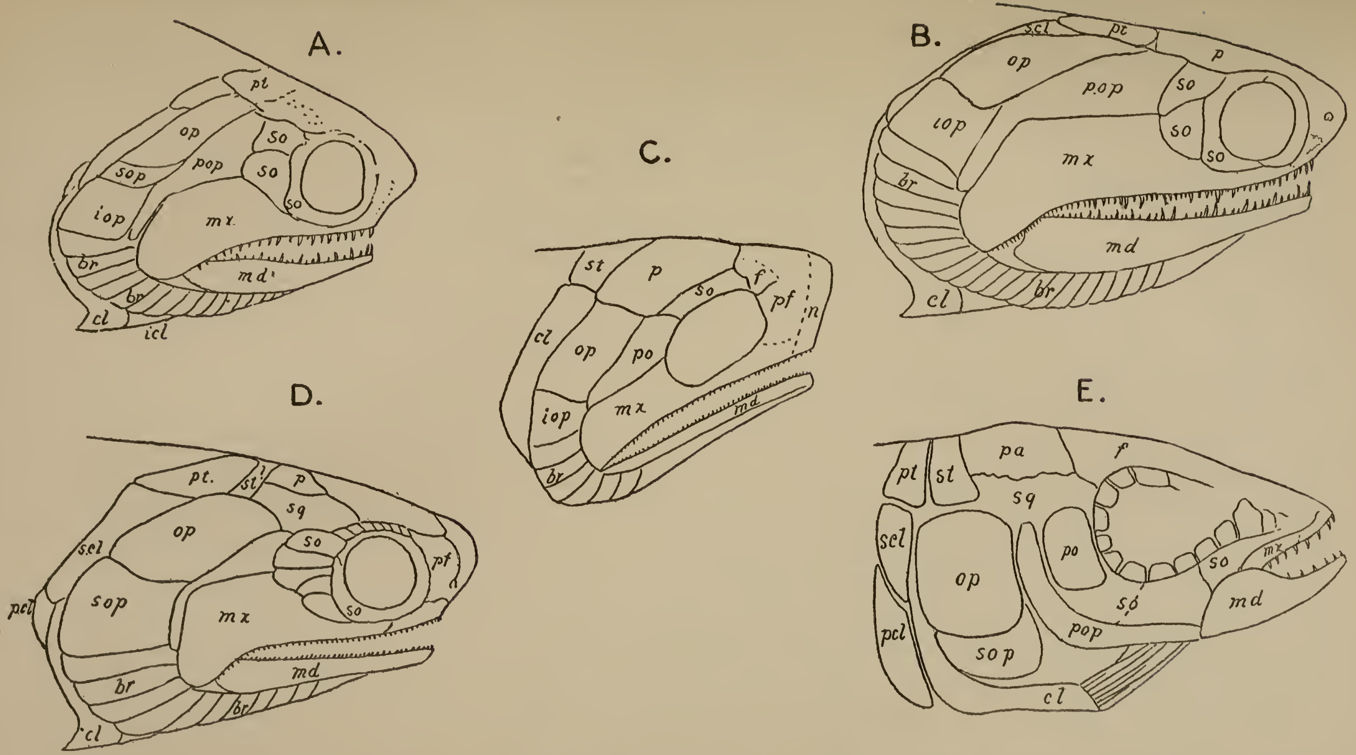
A.
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FIG. 7. Comparative Diagrams showing types of cranial structure presented by various Paleozoic Chondrosteans (A-D) as contrasted with the Triassic *Semionotus* (E). A, *Rhabdolepis,* Permian (after Traquair). B, *Nematoptychius,* Lower Carboniferous (after Traquair). C, *Rhadinichthys,* Lower Carboniferous (after Tornquist). D, *Palæoniscus,* Permian (after Traquair). E. *Semionotus,* Triassic (after Schellwien).

as their name implies, are a series of small plates surrounding the orbit. They are of polygonal contour (see Fig. 7), and are arranged in much the same fashion as in *Lepidotus,* those along the inferior border being of large size and extending some distance in advance of the upper row. Indications of a mucous canal are observable over part of the circumorbital ring in some species. Immediately below these plates are situated the suborbitals, which are fewer and much larger than in *Lepidotus, Dapedius,* and related genera. The line of demarcation between the suborbitals and contiguous plates has not been satisfactorily determined in any species thus far investigated.[1] The postorbital is a large thin plate situated between the hindermost circumorbitals and the operculum. It is sometimes in contact with the last-named plate posteriorly, as in *S. bergeri* and possibly in *S. nilssoni,* but may be entirely separated from it by the preoperculum, as in *S. capensis.*

The opercular apparatus consists of (1) a large operculum, of variable shape, but generally with a narrower upper border; (2) a narrow, falciform preoperculum, with the mucous canal interrupted and appearing as a series of perforations; (3) a suboperculum, the exposed surface of which generally exhibits a sublunate outline; and (4) a triangular interoperculum. The posterior borders of the operculum and interoperculum are embraced by a large and heavy plate, often very conspicuous, the clavicle. This is similar to the preoperculum in form, but is much more solid, and its terminal angle in front is frequently thickened or otherwise prominent. It is succeeded behind by one or two enlarged postclavicular scales. There is a series of branchiostegal rays, but these, like the coracoid, are seldom well preserved, and hence imperfectly known. The nature of the dentition has been sufficiently indicated in the foregoing family and generic diagnoses.

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[1] Nevertheless, the relations of these plates and also other details of the cranial osteology are shown with considerable clearness, amounting almost to certainty as regards some features, in a number of specimens of *Semionotus* from a locality a few miles north of Guilford, Connecticut. The material referred to was collected nearly a score of years ago by Mr. Loper, and is now preserved in the U. S. National Museum at Washington. Peculiar conditions of weathering, and perhaps also the admixture of much argillaceous matter in the rock, are responsible for the excellent portrayal of details. These specimens suggest an image of what the facial and cranial elements should look like, but the image is blurred, and refuses to shape itself in hard and fast lineaments which are requisite for a dependable restoration. It seems better to resist the temptation to reconstruct the arrangement of head parts from material which is highly suggestive but still not quite decisive. The same applies to well preserved specimens of *Catopterus* from the Connecticut Valley region, and to equally perfect examples of *Perleidus* from the Alpine province.

Concerning the use or abandonment of Egerton's generic term *"Ischypterus,"* we shall waste no time in killing dead lions. In this, as in previous articles on American Triassic fishes, the term in question is regarded merely as a synonym of Agassiz's earlier defined genus, *Semionotus*. We pass on now to a consideration of the different species occurring within the New England area.

### **Semionotus agassizii** (W. C. Redfield).

(Plates I, II; Text-figure 8.)

1841. *Palæoniscus agassizii* W. C. Redfield, Am. Journ. Sci., [1] xli, p. 26.
1850. *Ischypterus agassizii* Sir P. G. Egerton, Quart. Journ. Geol. Soc., vi, p. 10.
1856. *Ischypterus marshi* W. C. Redfield, Proc. Amer. Assoc. Adv. Sci., pt. 2, p. 188 (name only).
1888. *Ischypterus agassizii* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 30, pl. 3, fig. 1.
1888. *Ischypterus marshi* J. S. Newberry, *ibid.*, p. 28, pl. 2, fig. 1.
1903. *Semionotus marshi* G. F. Eaton, Am. Journ. Sci., [4] xv, p. 264, pl. 5, figs. 5, 9, 10, 12; pl. 6, figs. 1, 2.
1905. *Semionotus agassizii* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 80, pl. 1; pl. 2, figs. 5, 9, 10, 12; pl. 3, figs. 1, 2; pl. 7, 8.

A large and elegantly fusiform species, attaining a total length to the base of the caudal fin of about 25 cm., in which the length of the head and opercular apparatus is contained three and one-half times. The maximum depth occurs between the paired fins, where the number of longitudinal scale-rows is about twenty. The number of transverse scale-rows, counting along the lateral line, is about thirty-four. Scales everywhere large and thick. The boat-shaped dorsal ridge-scale covering the base of the dorsal fin anteriorly is rather small, rounded in front and not

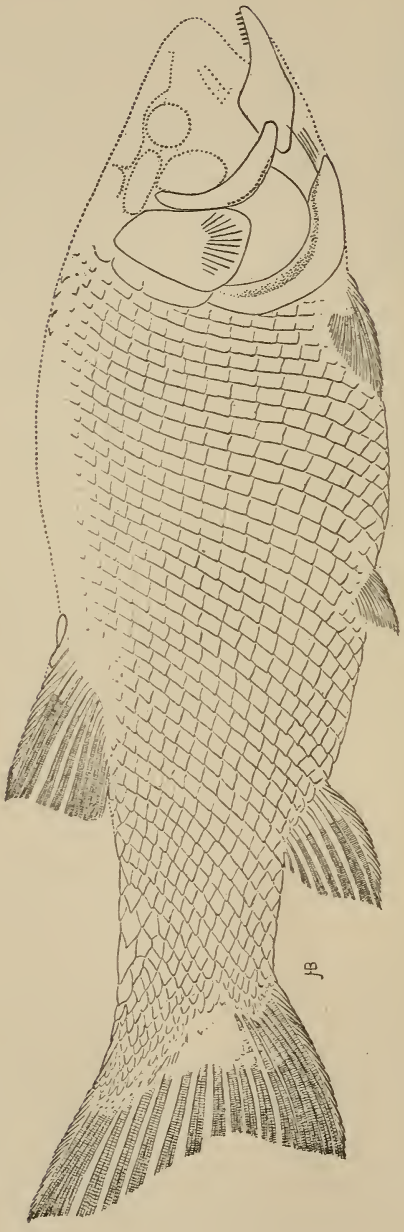

FIG. 8. Semionotus agassizii (W. C. Redfield). Trias; Sunderland, Massachusetts. Lateral aspect of nearly perfect specimen belonging to the American Museum of Natural History, New York. ×½.

notched behind, the posterior extremity prolonged instead into a fine point. Fins strong but relatively short-based, the caudal rather prominently furcate and with about seventeen rays. Dorsal, anal, and pectoral fins with about fourteen fulcra each, the ventral with about twelve. Apparently four dorsal fin-fulcra originate on the dorsal line over the basal supports, the fifth being slightly less than one-half the length of the anterior fin-margin. The fin-formula is stated to be as follows:

D. 9-10; C. 17; A. 9; P. 12.

This is one of the largest and most striking of the fossil fishes occurring within the Connecticut Valley region, easily recognized by its gracefully proportioned outline, regular and heavy squamation, and thickness of head bones. Less abundant than either *S. tenuiceps* or *S. fultus* which accompany it, it is distinguished from the former of these by the following differential characters, as was first pointed out by Newberry: the dorsal ridge-scales, which are usually depressed, are less strongly developed than in *S. tenuiceps,* and "the arch of the back does not show the hump which is so characteristic of that species; the fins are very strong; the fulcra of the dorsal and anal fins unusually broad and long, forming arches nearly half an inch wide at the base, curving gracefully backward to a point."

Remains of this species are common to both New Jersey and New England, the locality near Sunderland, Massachusetts, having furnished a number of excellently preserved specimens, including the type of the so-called *Ischypterus marshi.* A photograph of this particular individual is reproduced in Plate I of the present Report, and in Plate II is shown the head portion of the instructive example which served as the basis of Dr. Eaton's restoration, published in 1905. The originals of both plates are preserved in the Peabody Museum of Yale University, and equally perfect and important material is to be found in the American Museum of Natural History at New York. Other interesting specimens are the property of Amherst College and Wesleyan University, respectively. As long ago as 1845, the distribution of this species was stated by J. H. Redfield to be as follows: "Occurs at Sunderland, Mass.; Westfield and Middlefield, Conn.; Pompton and Boonton, N. J."[1]

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[1] Quoted by Newberry in his Monograph on Triassic Fishes, 1888, p. 30.

### **Semionotus fultus** (Agassiz).

(Plate III.)

1836. *Palæoniscus fultus* L. Agassiz, Poiss. Foss., ii, pt. 1, pp. 4, 43, pl. 8, figs. 4, 5.
1841. *Palæoniscus fultus* W. C. Redfield, Am. Journ. Sci., [1]xli, p. 25.
1841. *Palæoniscus macropterus* W. C. Redfield, *ibid.,* p. 25.
1847. *Ischypterus fultus* Sir P. G. Egerton, Quart. Journ. Geol. Soc., iii, p. 277.
1850. *Ischypterus fultus* Sir P. G. Egerton, *ibid.,* vi, pp. 8, 10.
1877. *Ischypterus fultus* R. H. Traquair, *ibid.,* xxxiii, p. 559.
1888. *Ischypterus fultus* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 34, pl. 6, fig. 2; pl. 7, fig. 1.
1895. *Semionotus fultus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 3, p. 58.
1901. *Semionotus fultus* E. Schellwien, Phys.-ökon. Gesellsch. Königsberg, p. 29, pl. 3, figs. 4 (?), 5.
1903. *Semionotus fultus* G. F. Eaton, Am. Journ. Sci., [4] xv, p. 261, pl. 5, figs. 1-4.
1905. *Semionotus fultus* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 83, pl. 2, figs. 1-4; pl. 9.

The synonymy given above is that adopted by most recent writers. The two species, *S. fultus* and *S. macropterus,* were first united by J. H. Redfield in his paper presented before the American Association of Geologists and Naturalists in 1845, but were afterwards held by Newberry to be distinct on account of slight, and, as a matter of fact, inconstant differences in their body proportions. It is now commonly recognized that minor differences of this nature are the result of accidental conditions of preservation. Following are the chief diagnostic features of this species:

D. 10; C. 15; A. 10; P. 10.

A gracefully fusiform species attaining a total length to the base of the caudal fin of about 15 cm., in which the length of the head and opercular apparatus is contained three and one-half times. The maximum depth of trunk, which is equal to about one-fourth of the total length, occurs midway between the head and dorsal fin, where there are about twenty longitudinal rows of scales. Scales of lateral line about thirty-three. Dorsal fin arising at mid-length, pectorals nearer to the anal than to the pelvic fins, arising opposite a point directly in advance of the dorsal. Caudal not much forked. Anal with ten rays, partly opposed to hinder half of the dorsal, its origin being on the third oblique scale-row in advance of the dorsal fin. Dorsal fin-fulcra about twelve; anal ten; ventral and pectoral ten each. Apparently four dorsal fin-fulcra originate on the dorsal margin over the interneurals. The fifth dorsal fulcrum has its origin adjacent to that of the first ray, and is about equal in length to one-half the anterior margin of the fin. Scales smooth and not serrated posteriorly, the deepest ones occurring in the fourth row behind the clavicular arch; these are about twice as deep as they are wide in their exposed portion. Dorsal ridge-scales acuminate.

As has been stated, the sole criterion relied upon by Newberry for maintaining the so-called *S. macropterus* as an independent species consisted in a supposed relatively greater depth of body, —"the fusiform and slender fish standing for *I. fultus,* and the broader one for *I. macropterus.*" Curiously enough, it has been shown by Dr. Eaton, after a study of Newberry's originals in the American Museum of Natural History, that, whereas one of the specimens of *S. macropterus* in its compressed and flattened condition is deeper than a type of *S. fultus,* all the others are proportionally more slender.[1] J. H. Redfield, after advocating the suppression of the trivial title *macropterus,* remarks that *S. fultus* is specially characterized by the length of the dorsal and anal fins, which are even longer than in *S. tenuiceps.*[2]

In the New Jersey area, this species outnumbers all others in abundance, and in the Connecticut Valley Trias it is scarcely inferior in numerical importance to the ubiquitous *S. tenuiceps.* The average length of body is stated by Newberry to be about six inches, the maximum rarely exceeding eight inches, including the caudal fin. In Plate III is given a photographic reproduction of one of the original specimens serving for Newberry's description.

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[1] *Loc. cit.,* 1903, p. 262.

[2] Cited by Newberry, 1888, p. 35.

### Semionotus tenuiceps (Agassiz).

1836. *Eurynotus tenuiceps* L. Agassiz, Poiss. Foss., ii, pt. 1, pp. 159, 203, pl. 14*c*, figs. 3, 4, 5.
1837. *Palæoniscus latus* J. H. Redfield, Ann. Lyceum Nat. Hist. N. Y., iv, p. 38, pl. 2.
1837. *Eurynotus tenuiceps* J. H. Redfield, *ibid.*, p. 39.
1841. *Eurynotus tenuiceps* E. Hitchcock, Geol. Mass., ii, p. 459, pl. 29, figs. 1, 2.
1841. *Palæoniscus latus* W. C. Redfield, Am. Journ. Sci., [1] xli, p. 25.
1850. *Ischypterus latus* Sir P. G. Egerton, Quart. Journ. Geol. Soc., vi, p. 10.
1857. *Eurinotus ceratocephalus* E. Emmons, Am. Geol., pt. 6, p. 144, pl. 9a.
1860. *Eurinotus ceratocephalus* E. Emmons, Manual Geol., 2d ed., p. 188, fig. 164.
1877. *Ischypterus latus* R. H. Traquair, Quart. Journ. Geol. Soc., xxxiii, p. 559.
1888. *Ischypterus tenuiceps* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 32, pl. 5, figs. 1-3, pl. 7, fig. 3.
1889. *Allolepidotus americanus* W. Deecke, Palaeontogr., xxxv, pp. 103, 114.
1895. *Semionotus tenuiceps* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 3, p. 59.
1903. *Semionotus tenuiceps* G. F. Eaton, Am. Journ. Sci., [4] xv, p. 295.
1905. *Semionotus tenuiceps* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 87.

A species attaining a total length of about 20 cm., and readily distinguished from all others (except in young stages) by the excessive development of the dorsal ridge-scales; these are very large and conspicuous, and, in mature individuals, comparatively obtuse. The anterior dorsal outline is considerably arched, usually forming a characteristic "hump" immediately behind the head. Length of head and opercular apparatus less than the maximum depth of the trunk, and contained four times in the total length of the fish. Fins as in *S. fultus.* Scales smooth and serrated, those of the middle of the flank in part twice as deep as broad. The dorsal ridge-scale immediately in advance of the dorsal fin has its posterior border obtuse, and not produced, and the corresponding ridge-scale in front of the anal fin is notched behind. Ribs more strongly developed than in any other species of the genus.

This, the commonest form occurring within the Connecticut Valley area, is as a rule easily determinable, its most conspicuous features being the abrupt elevation of the dorsal outline immediately behind the head, and the spiny appearance of the back occasioned by its being set along the middle with long, thickened, and distally pointed or clavate ridge-scales. The ribs also are more strongly developed than in other species, their curved outlines being sometimes traceable even when covered with scales. Owing to the frequency with which this species has been illustrated, and the impossibility of mistaking it among collections of Triassic fishes, it has not been deemed essential to include a figure of it in the present Report.

*S. tenuiceps* outnumbers all other species in the Connecticut Valley Trias, and is tolerably abundant also in New Jersey. At Turner's Falls and at Sunderland, Massachusetts, it is especially common, probably more than half of the individuals derived from the latter locality pertaining to this form.

### **Semionotus micropterus** (Newberry).

(Plate IV.)

1888. *Ischypterus micropterus* J. S. Newberry, Trans. N. Y. Acad. Sci., vi, p. 127 (name only).

1888. *Ischypterus micropterus* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 31, pl. 4, figs. 1, 2; pl. 12, fig. 2.

1893. *Ischypterus newberryi* S. W. Loper, Pop. Sci. News, March 18, and Pop. Science, May, 1899, p. 98.

1903. *Semionotus micropterus* G. F. Eaton, Amer. Journ. Sci., [4] xv, p. 263, pl. 5, figs. 6-8, 11, 13.

1905. *Semionotus micropterus* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 87, pl. 2, figs. 6-8.

D. 8; C. 15; A. 8.

A regularly fusiform species attaining a total length to the base of the caudal fin of about 20 cm., the maximum depth occurring shortly behind the pectoral fins and amounting sometimes to nearly one-half the total length. The dorsal and ventral contours are more strongly arched than in *S. fultus,* but the relative position and size of the fins are about the same for both species. Dorsal, anal, and pectoral fin-fulcra relatively shorter than in *S. fultus.* Apparently three dorsal fin-fulcra originate on the dorsal line over the interneurals. The fifth dorsal fulcrum has its origin on the anterior margin of the anterior ray at a considerable distance from its base, and is about one-third as long as the anterior fin-margin. Pectorals with upwards of twenty fulcra. Ridge-scales moderate, spiniform, the one immediately in advance of the dorsal fin slightly produced into a point behind. Scales frequently serrated, those below the lateral line on the flanks tending to become bi- or tridentate on the postero-inferior angle.

This is a deeper-bodied species than any thus far considered, its rather strongly convex outline marking a transition between the types presented by *S. fultus,* for instance, and *S. ovatus.* Indeed, the approach to the last-named species in this respect is sometimes so close as to make a rigid distinction difficult without the aid of other characters. In the case of the specimen selected for illustration in Plate IV, Newberry himself appears to have been in doubt whether to refer it to *S. micropterus* or *S. ovatus,* but finally decided in favor of the former, as shown by MS. records accompanying the original. The most reliable means for identifying the present species is furnished by fin characters, the details of which have been carefully worked out by Dr. Eaton in his paper of 1903, and are incorporated in the above definition.

Remains of this species are fairly abundant in the Connecticut Valley Trias, and show considerable variation of size; that is to say, young individuals occur somewhat numerously, so that gradations may be traced up to the maximum recorded by Newberry. He states that the largest individuals known to him attain a length of ten and one-half inches, and the smallest are "only about three and one-half inches long." Corresponding with the last given dimension, and otherwise agreeing with the characters of this species, is the holotype of the late Mr. S. Ward

Loper's *Ischypterus newberryi.* The peculiarity to which Mr. Loper has called attention, namely, fine concentric scale-markings, seems to have been occasioned by some form of chemical corrosion which has exposed the growth lines. A parallel instance has already been noticed in the case of *Catopterus ornatus* (*supra,* p. 55), and similar conditions are prevalent among fishes of the English Chalk. The original of Mr. Loper's description is of interest for showing a well preserved mandible beset with numerous slender teeth, and a very strongly developed support for the dorsal and anal fins. It is preserved in the Museum of Wesleyan University, and was obtained by Mr. Loper from the anterior shale near North Guilford, Connecticut.

This species is not known to occur elsewhere than within the state of Connecticut, and is especially abundant in the vicinity of Durham. It is possible that the detached head figured by Dr. E. Schellwien in Plate 3, Fig. 4 of his memoir above cited belongs to *S. micropterus,* since this is one of the few species in which the cheek plates are granulated.

### Semionotus ovatus (W. C. Redfield).

1842. *Palæoniscus ovatus* W. C. Redfield, Am. Journ. Sci., [1] xli, p. 26.
1847. (?) *Tetragonolepis* Sir P. G. Egerton, Quart, Journ. Geol. Soc., iii, p. 277.
1850. *Ischypterus ovatus* Sir P. G. Egerton, *op. cit.* vi, p. 10.
1888. *Palæoniscus ovatus* J. H. Redfield (quoted by Newberry), Monogr. U. S. Geol. Surv., xiv, p. 27.
1888. *Ischypterus ovatus* J. S. Newberry, loc. cit., p. 27, pl. i, fig. 1.
1903. *Semionotus ovatus* G. F. Eaton, Am. Journ. Sci., [4} xv, p. 266.
1905. *Semionotus ovatus* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 78, pl. 4-6.

A large species attaining a total length of about 20 cm., with trunk very much deepened midway between the head and dorsal fin. Scales large and thick, becoming gradually deepened toward the middle of the flanks; tail strong and considerably expanded. Number of dorsal and anal fin-fulcra greater than in any other species, each fin having sometimes twenty or more. Length of the longest fulcrum of the dorsal fin nearly equalling one-half that of the anterior margin of the fin.

In the original description of *S. ovatus* by William C. Redfield, it is stated that "it exceeds all the known American species in the comparative width or roundness of its form, and is also remarkable for the large size of its scales. It is of rare occurrence, and, owing probably to its great thickness, is seldom obtained in a perfect form." The younger Redfield, commenting on the same species in 1854, pronounced it "the broadest and most ovate species of *Palæoniscus* that is known," and added further, that "in size of the scales it resembles *P. Agassizii*, but its form will readily distinguish it." That is to say, the squamation is heavy, but the flank-scales are relatively deeper than in *S. agassizii*, and the form is also deeper-bodied, or more ovate.

The Redfields, father and son, and also Newberry, agree in claiming for this species a distribution in both the Connecticut Valley and New Jersey Triassic basins. With this species Newberry also identifies a fragmentary individual from the Triassic Coal-field of Virginia, originally referred to *Tetragonolepis* by Sir Philip Grey Egerton. Noteworthy is the fact that all the more perfect examples have been obtained from a single locality near Boonton, New Jersey, and the recognition of this species in outlying areas depends upon the evidence of unsatisfactory material. The present writer has thus far failed to discover a single undoubted example of the species in question from the Connecticut Valley Trias, yet this is by no means equivalent to saying that its remains do not occur in this region. It may perhaps be worth mentioning that in the Museum of Wesleyan University is preserved the anterior half of a deep-bodied fish (Cat. No. 869) whose specific relations cannot be accurately determined. It is labeled as belonging to *S. gigas*, a "species" which can be maintained only in a provisional sense. The so-called *Semionotus robustus* of Newberry is but little better known, and is doubtfully distinct from *S. ovatus*, which it approximates in size. A certain resemblance between the published figure of *S. robustus* and the imperfect deep-bodied specimen at Wesleyan University just referred to cannot be denied. Further evidence, however, is necessary before we can positively affirm the presence of *S. ovatus* in the New England area.

### *Extra-limital Species of Semionotus.*

At least three other valid species of *Semionotus,* besides those already enumerated, have been described from the Trias of Eastern North America. These are, *S. lineatus, elegans,* and *brauni* of Newberry. They are all confined to the New Jersey area, so far as known, and the last-named is from the very base of the Trias in that state, being separated from the Boonton horizon by an interval of several thousand feet. The limits set to the present Report do not admit of elucidating the characters of these species, which can by no possibility be confused with the members of our local fauna. Nevertheless, it has been thought desirable to offer an illustration of the form which has been appropriately named *S. elegans* by Newberry (Plate V), and also to show the head-portion of the type specimen of *S. nilssoni* (Plate VI), which enabled Agassiz to decipher the main elements of the cranial structure of this genus.

To the list of imperfectly defined or doubtful species, the status of which is merely provisional, must be added the names of the so-called *Ischypterus parvus,* founded upon a figure published in Hitchcock's Geology of Massachusetts, in 1835; *Ischypterus minutus* Newberry, from Durham, Connecticut; and *Ischypterus beardmorei* Smith, from Boonton, New Jersey. Of uncertain position also are the obscure remains of a Semionotus-like form described by Newberry under the name of *Acentrophorus chicopensis,* the few known examples of which have been obtained from metamorphosed sandy shales near Chicopee Falls, Massachusetts.

It will be convenient to notice at this point the status of an imperfectly known European form, described in the first instance by Deecke as a species of *Semionotus,* and recently made the type of a distinct genus (*Perleidus*) by De-Alessandri, who places it in association with the Catopteridæ. The type species, *P. altolepis* (Deecke), occurs in the Ladinian beds of Perledo, Lombardy, and the original specimen upon which it is founded is preserved in the Senckenbergian Museum at Frankfurt. Deecke, in describing the species, remarked that it appeared to him to denote a transitional stage between the genera *Semionotus* and *Pholidophorus.* Schellwien, who later examined the specimen, doubted whether it could properly be included in the genus

*Semionotus,* but did not attempt to fix its systematic position more precisely.

The reasons which in Professor De-Alessandri's opinion justify a removal of this species, and with it the new genus *Perleidus,* to the group of Catopterids, are enumerated by this author as follows: "The arrangement of the cranial elements, the form of the maxilla, especially its expanded posterior portion, the absence of suborbital plates, and the presence of a large-sized postorbital, compel an assignment of this form to the family of Catopteridæ, and make it necessary for us to regard it as the type of a new genus. Moreover, the position and form of the fins, the rather feeble fulcra, the configuration of the scales with their strongly denticulated posterior border, and the absence of a series of acuminate dorsal ridge-scales, are characters which warrant a separation from the genus *Semionotus.*"[1]

The new genus *Perleidus* is thus diagnosed by its founder: "Trunk elongate-fusiform, and head relatively small. Superficial ornament of the cranial plates consisting of rather fine tuberculations and rugæ. Maxilla extended, and posteriorly enlarged. A series of circumorbitals present, but no suborbitals; one large postorbital plate present. Fins moderately developed, comprising robust articulated rays; fulcra small. Dorsal fin situated opposite the pelvic pair; caudal slightly forked. Scales rhomboidal, deeper than long, smooth on their exposed portion, their posterior border denticulated."[2]

That the above-mentioned genus is well characterized there can be no doubt, and the reasons for excluding it from association with *Semionotus* are sufficiently valid. It must be admitted, however, that the form in question presents considerable resemblance to *Pholidophorus,* and the position of the dorsal fin, which arises in advance of the anal, offers a marked contrast to the condition observed in the family Catopteridæ, from which condition indeed is derived the name of the typical genus. We prefer to accept the Milanese author's determination of the family position of this genus in a provisional sense, rather than to assign it elsewhere without having had opportunity to study the actual specimens.

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[1] Studii sui Pesci Triasici della Lombardia. *Mem. Soc. Ital. Sci. Nat.,* 1910, vii, p. 51.

[2] *Loc. cit.,* p. 49.

### Family EUGNATHIDÆ.

Trunk fusiform or elongate, not much laterally compressed. Cranial and facial bones moderately robust, externally enameled, and opercular apparatus complete; gape of mouth wide, snout produced, marginal teeth conical and larger than the inner teeth. Fin-rays robust, articulated, and distally divided; fulcra conspicuous. Dorsal fin short and acuminate. Scales rhombic, sometimes with rounded posterior angles.

### Genus **Ptycholepis** Agassiz.

Trunk elegantly fusiform; snout acutely pointed and prominent; external bones highly ornamented with prominent waved ridges; marginal teeth very small and regular; dorsal fin in advance of anal, caudal fin forked; scales all narrow and elongate, marked with deep longitudinal grooves. Fulcra biserial, conspicuous on all the fins excepting the dorsal.

### **Ptycholepis marshi** Newberry.

(Plates VII, VIII.)

1878. *Ptycholepis marshi* J. S. Newberry, Ann. N. Y. Acad. Sci., i, p. 127.
1888. *Ptycholepis marshi* J. S. Newberry, Monogr. U. S. Geol. Surv., xiv, p. 66, pl. 19, figs. 1, 2.
1895. *Ptycholepis marshi* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 3, p. 324.
1905. *Ptycholepis marshi* C. R. Eastman, Ann. Rept. N. J. Geol. Surv. for 1904, p. 100.
1908. *Ptycholepis marshi* L. Hussakof, Bull. Am. Mus. Nat. Hist., xxv, p. 95.

A species of slender proportions, attaining a length of about 20 cm. Head with opercular apparatus occupying somewhat more than one-fourth the total length of the fish. Ornamental rugæ of cranial roof slightly radiating; those of the facial and opercular plates more or less parallel and forked. Dorsal fin far forwards, and pelvic fins arising opposite its hinder extremity. Scales exhibiting only longitudinal ridges and furrows, and the hinder border often deeply serrated. (Woodward.)

This gracefully formed and elaborately ornamented species is known by a dozen or more examples, all derived from a single locality near Durham, Connecticut. Among these are several excellently preserved individuals, including the type shown in Plate VII, material which might be expected under ordinary circumstances to yield valuable enlightenment concerning cranial structure. Progress in this direction, however, is subject to the limitations imposed by the peculiar nature of the head bones themselves: that is to say, by the highly sculptured and heavily enameled outer surface which completely conceals suture lines. It is nevertheless permissible to draw certain inferences concerning the extent and arrangement of plates forming the cranial roof by noting the centers of radiation and territory traversed by the superficial radiating rugæ; and the general pattern thus revealed has been found to agree with typical Eugnathidæ. The dorsal aspect of the cranial roof, together with some of the facial bones and opercula, is favorably exposed for study in the specimen represented in Plate VIII, the original being preserved in the Yale Museum (Cat. No. 2608). The lateral aspect is even more favorably shown in the original of Plate VII, which is the property of Wesleyan University Museum (Cat. No. 907). This example, though of a young individual, is admirable for its presentation of fin and scale structure, and for showing the normal body contour.

In connection with the distribution of this form, it should be recalled that its accompaniment by *Semionotus, Catopterus* and a Crossopterygian genus (*Diplurus*) is a fact of capital importance in assigning the fauna in question to a horizon equivalent to the Upper Muschelkalk and Lower Keuper of the European marine Trias. All the evidence derived from a study of the fossil fishes is in favor of establishing a correlation at a level embracing these two horizons, but probably not extending higher than the basal division of the Keuper in the Mediterranean region.[1] For a recent review of the evidence for establishing an inter-regional correlation of the Trias, based upon another class of remains than fossil fishes, we may be permitted to refer at this point to Dr. J. C. Merriam's elaborate memoir on "Triassic Ichthyosauria, with special reference to American forms" (especially the chapter on Geologic and Geographic occurrence, pp. 12-20).[2] The evidence as to the age of the Triassic formation of eastern North America which is furnished by reptilian remains (*i. e.*, numerous footprints and a few skeletons of Dinosaurs) will be discussed in a forthcoming Bulletin of the Connecticut State Survey by Professor R. S. Lull of Yale University.

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[1] That is, the Newark fauna cannot be regarded as younger than the faunas of Besano, Lombardy, and of Raibl, Carinthia (Lower Alpine Keuper), which mark the uppermost range of one of the intercommunal genera *Ptycholepis*. The Upper Muschelkalk (Ladinian) terms of comparison are furnished by two Semionotid genera, one Captopterid, and one Crossopterygian, according to the revised determinations of Professor G. De-Alessandri (1910).

In conclusion, the writer of the present article desires to acknowledge his indebtedness and at the same time return hearty thanks to the following named friends and colleagues who have shown him many courtesies and placed numerous facilities at his disposal, thereby greatly aiding the preparation of this Report: Professor William North Rice and the late Mr. S. W. Loper of Wesleyan University; Professor Charles Schuchert and Dr. George F. Eaton of Yale; Professor B. K. Emerson and F. B. Loomis of Amherst; Professor Bashford Dean and Dr. E. O. Hovey of the American Museum of Natural History, New York; and the authorities of the U. S. National Museum at Washington.

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[2] *Memoirs of the Univ. of California*, 1908, i, no. 1, pp. 1-196, pl. 1-18.

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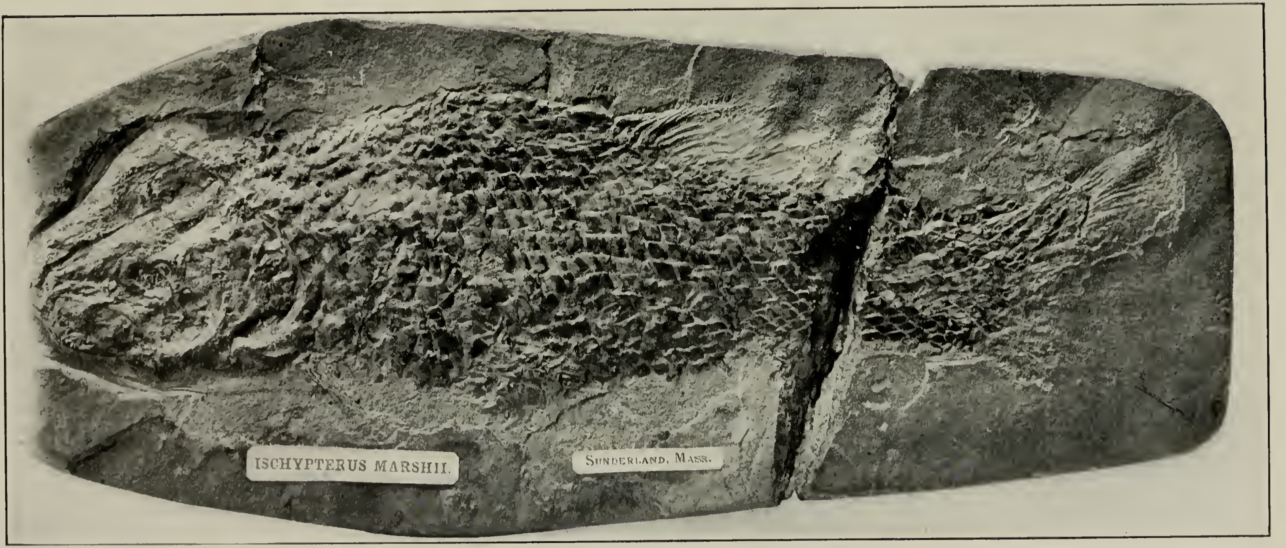
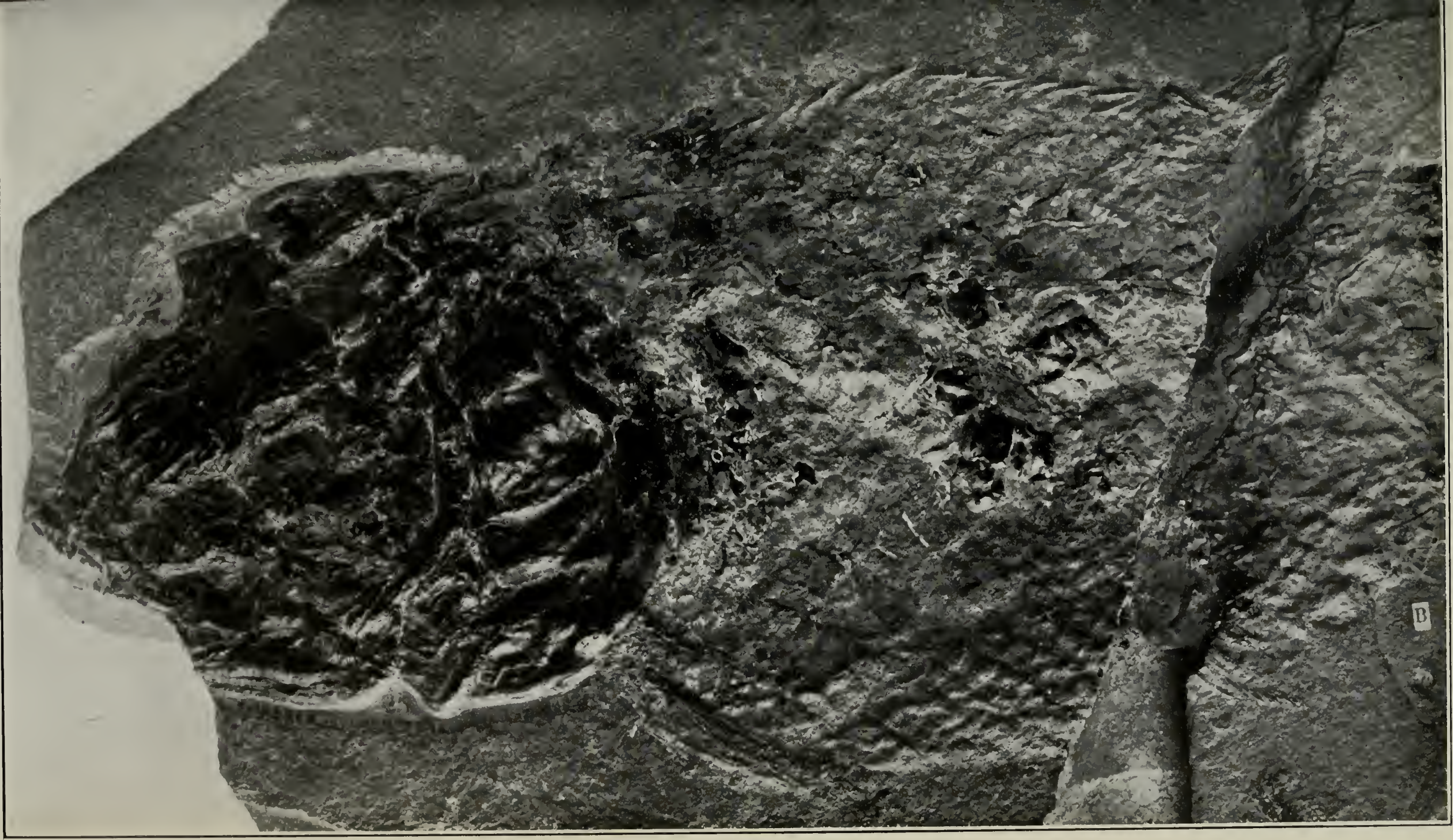
# PLATE I.

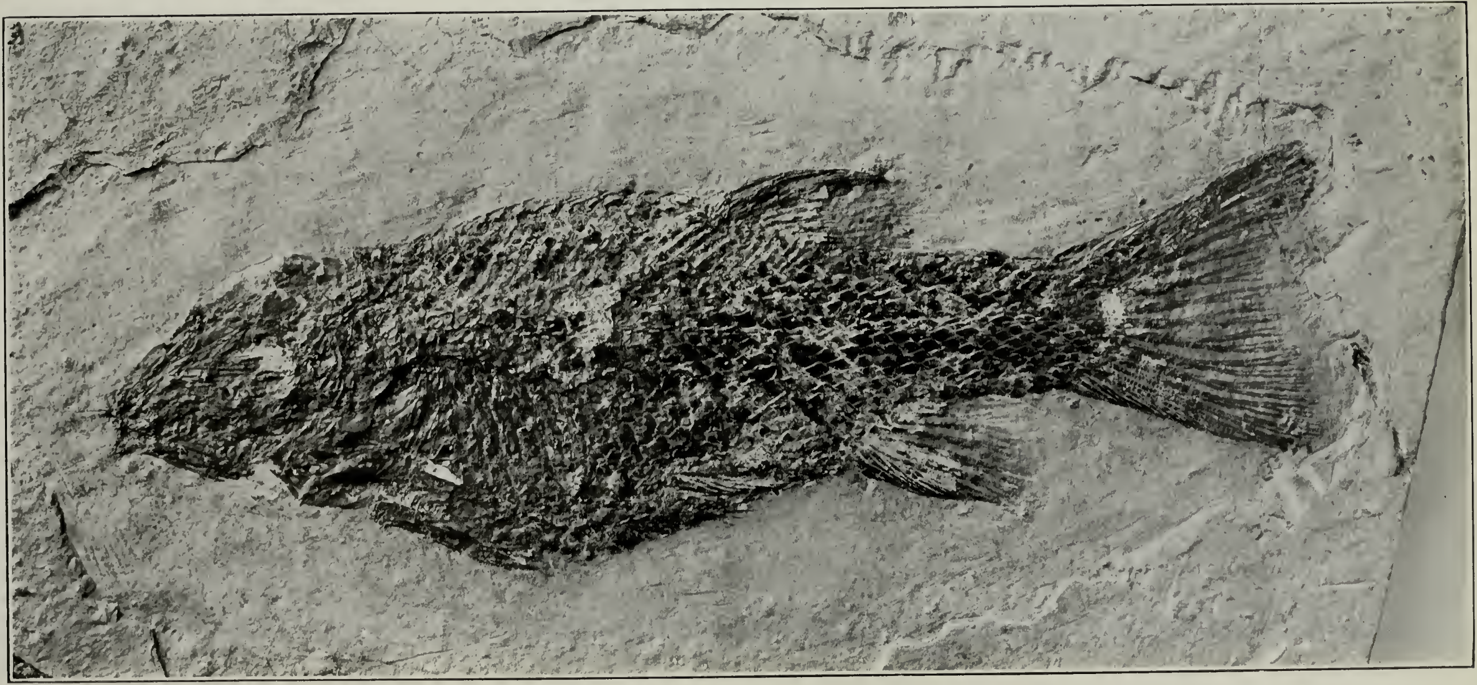

ISCHYPTERUS MARSHII.
SUNDERLAND, MASS.

*Semionotus agassizii* (W. C. Redfield). Trias; Sunderland, Massachusetts. This specimen is the type of Newberry's *Ischypterus marshii.* Original in Peabody Museum of Yale University. × $\frac{1}{2}$.



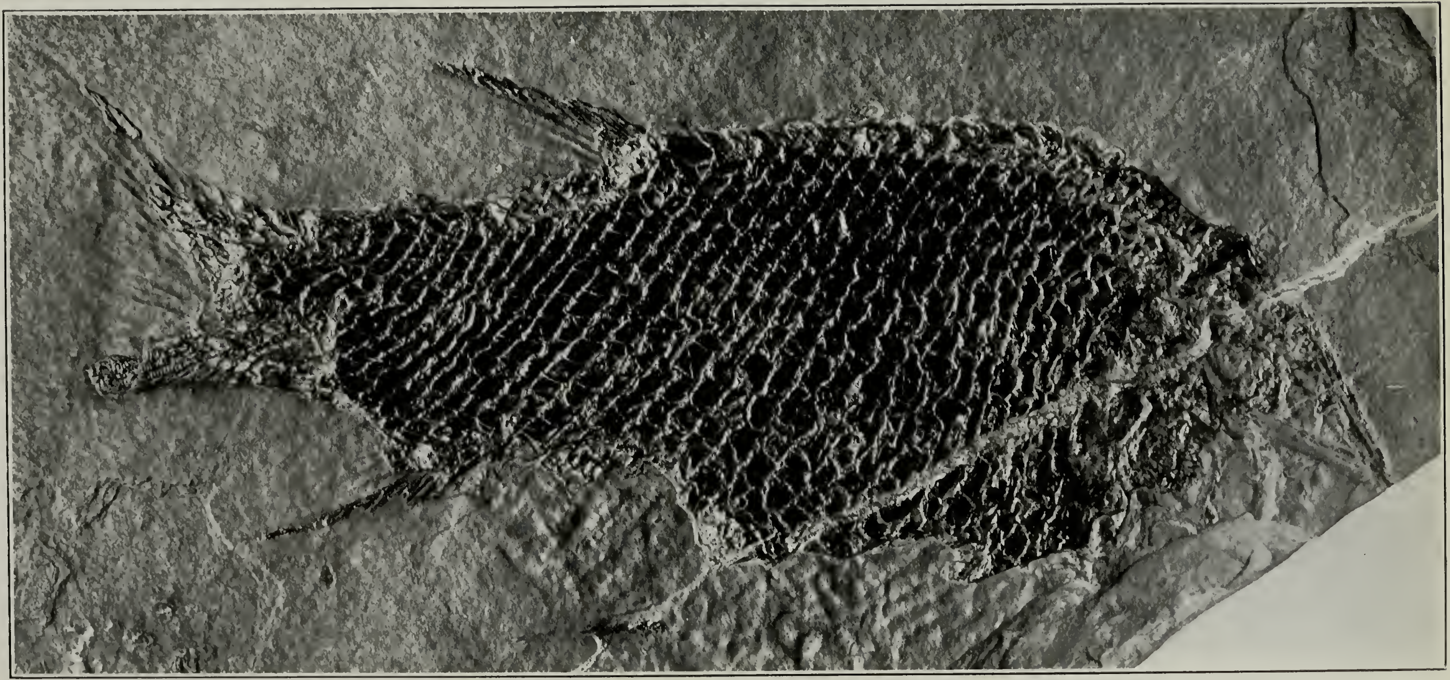
*Semionotus agassizii* ( W. C. Redfield )    Trias ;  Sunderland, Massachusetts.   Head and anterior portion of the trunk of a well preserved individual serving as the basis of Dr. Eaton's restoration of the cranial osteology.   Original in Peabody Museum of Yale University.   × $\frac{1}{1}$.

# PLATE III



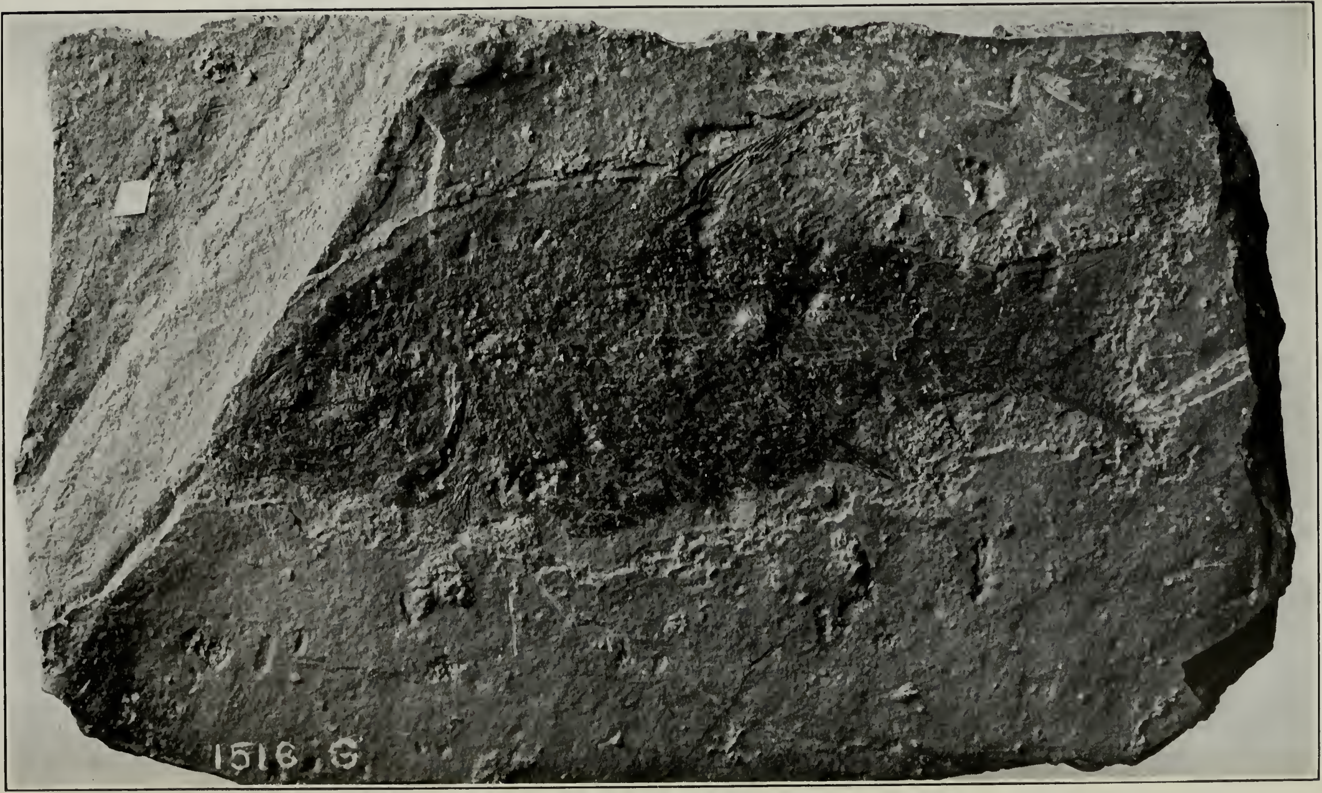
*Semionotus fultus* (Agassiz). Trias; Boonton, New Jersey. Nearly complete fish, illustrated in Plate 6, Fig. 2, of Newberry's Monograph. Original in American Museum of Natural History, New York. $\times \frac{7}{8}$.

# PLATE IV.



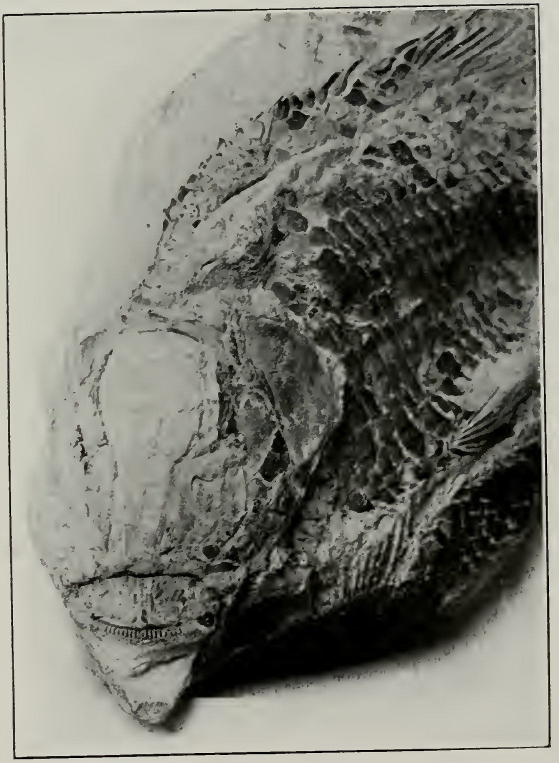
*Semionotus microptorus* (Newberry). Trias; Durham, Connecticut. Average-sized example, rather imperfectly preserved, showing convex contour of body, regular squamation, and characters of dorsal fin. Original in American Museum of Natural History, New York. $\times \frac{7}{8}$

PLATE V.



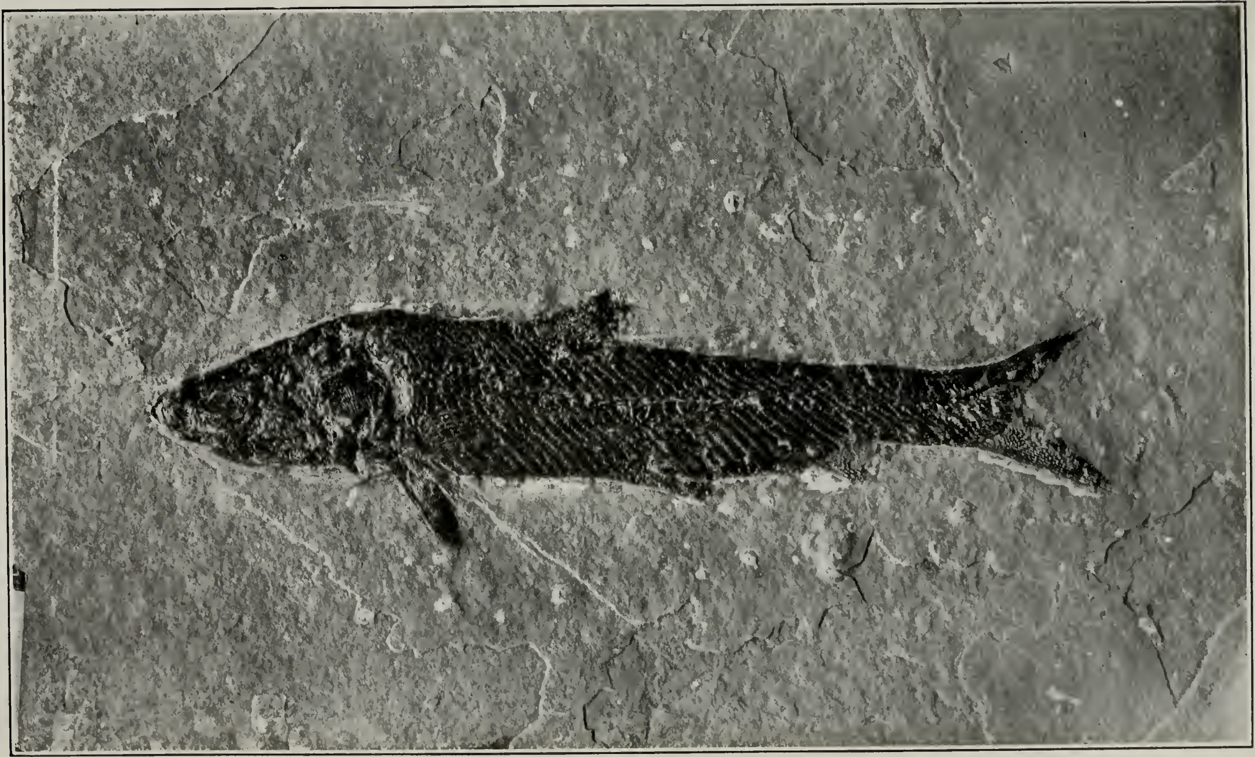
*Semionotus elegans* (Newberry). Trias; Boonton, New Jersey. Nearly complete fish, illustrated in Plate 14, Fig. 1, of Newberry's Monograph. Original in American Museum of Natural History, New York. $\times \frac{1}{1}$.

# PLATE VI.



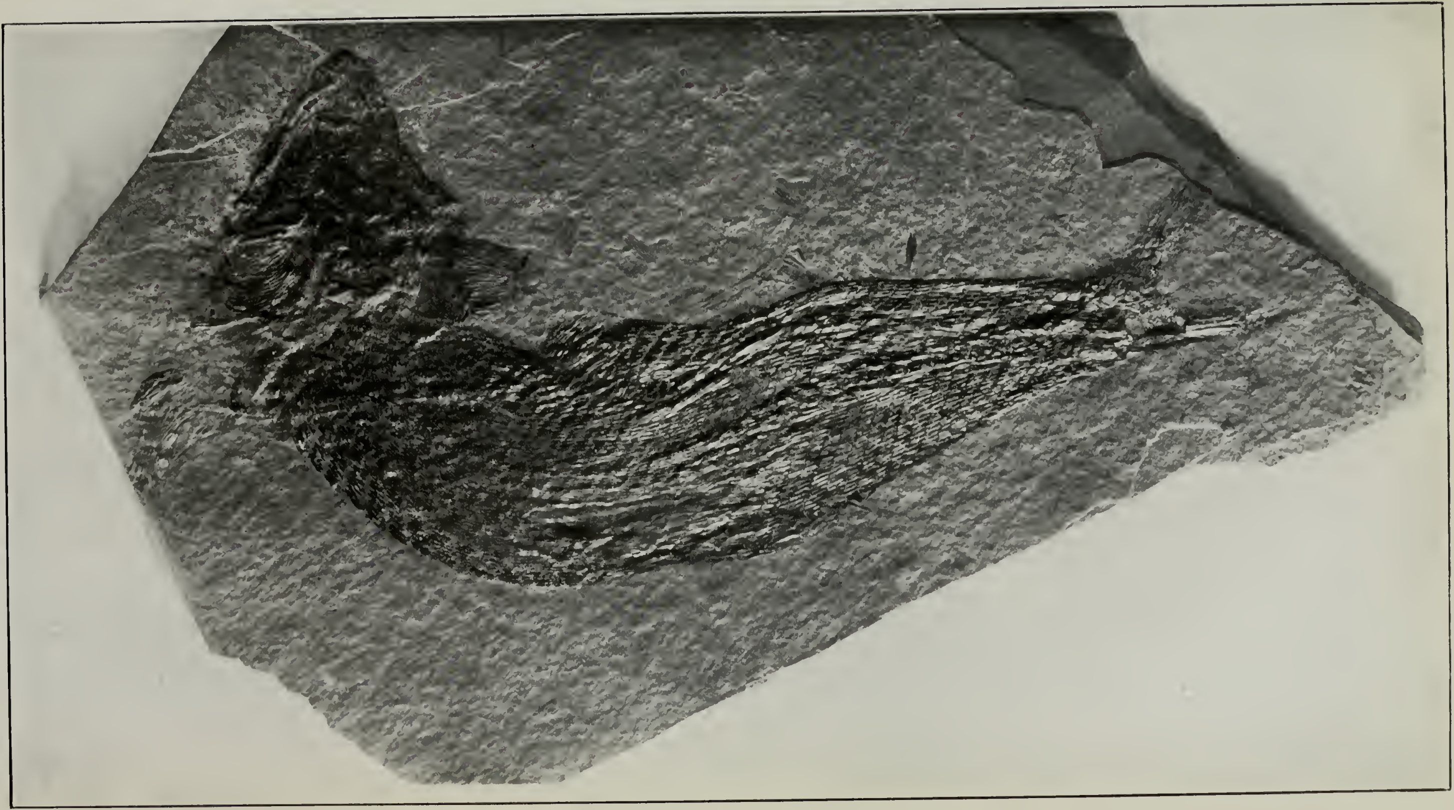
*Semionotus nilssoni* Agassiz. Rhaetic; Hoegenaes, Sweden. Head portion of holotype, showing cranial plates and dentition. Original in Museum of Comparative Zoology, Cambridge, Massachusetts (Cat. No. 2685). × $\frac{1}{1}$.

PLATE VII.



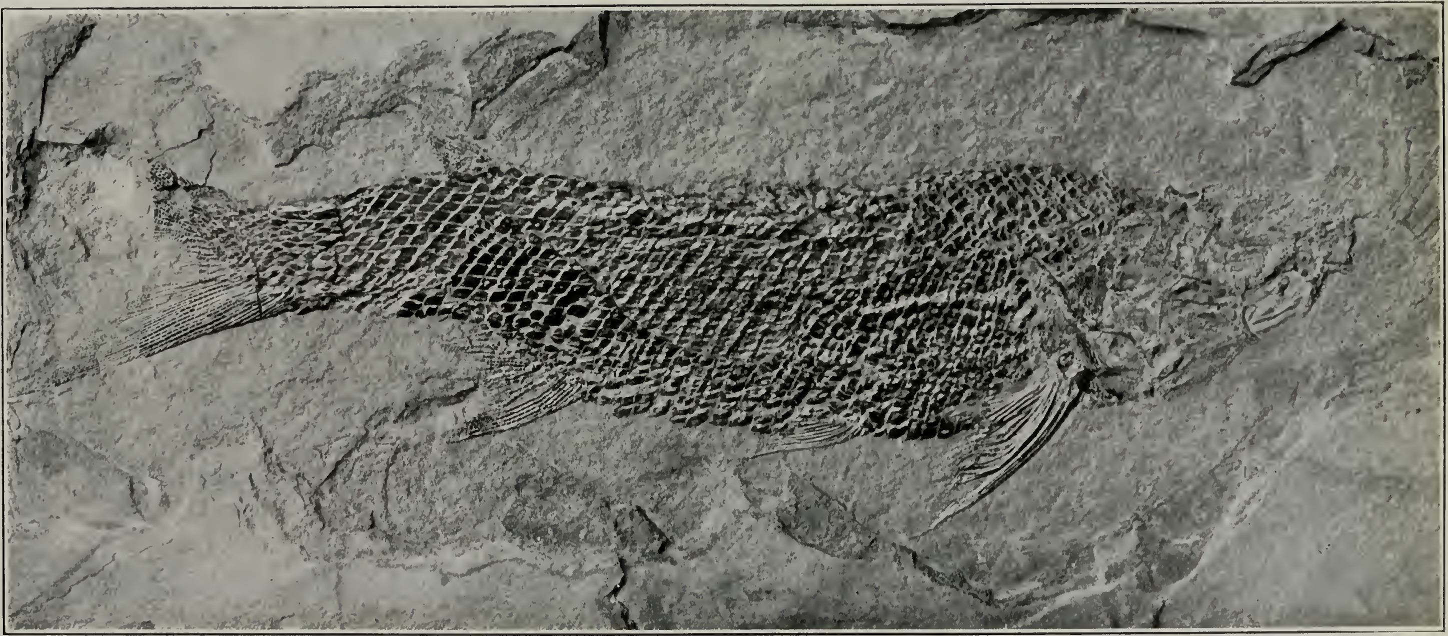
*Ptycholepis marshi* Newberry. Trias; Durham, Connecticut Complete fish, illustrated in Plate 19, Fig. 1, of Newberry's Monograph. Original in Museum of Wesleyan University. × $\frac{1}{1}$.

# PLATE VIII.



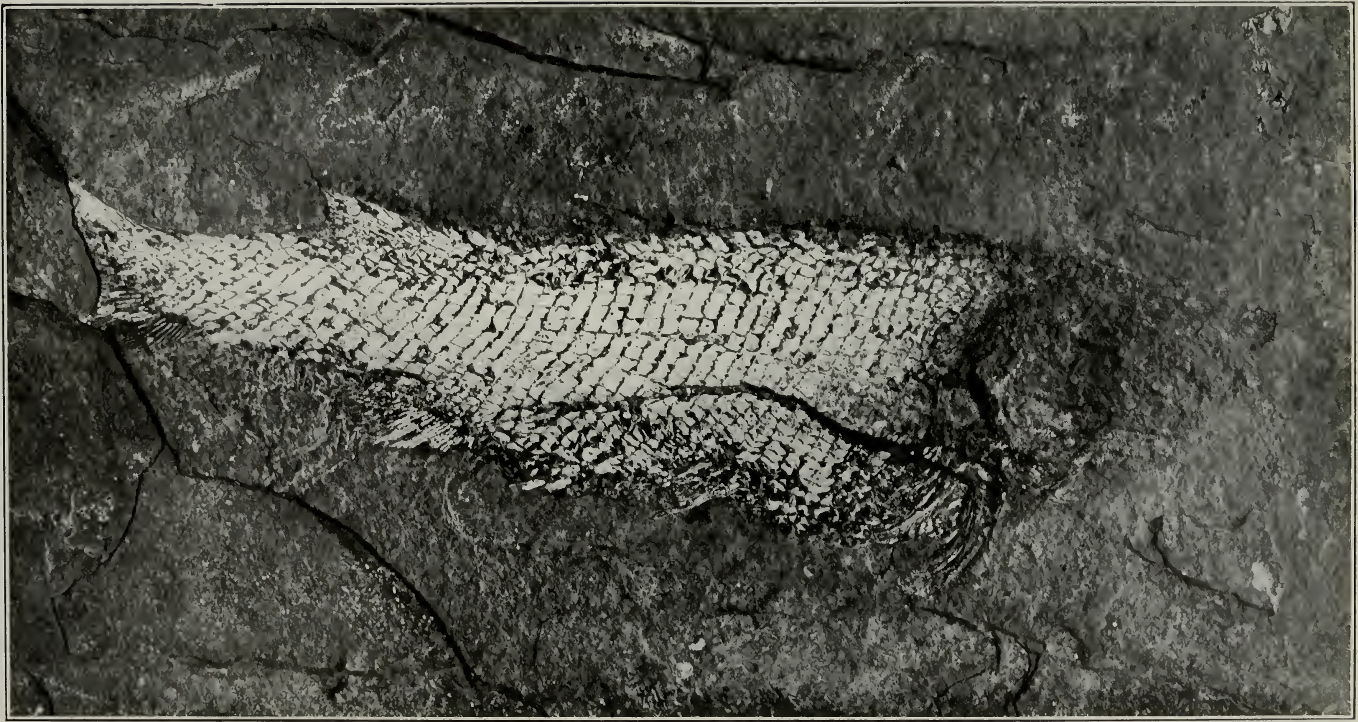
*Ptycholepis marshi* Newberry. Trias; Durham, Connecticut. Well preserved fish, showing dorsal aspect of flattened-out cranium. Original in Peabody Museum of Yale University. × $\frac{1}{1}$.

# PLATE IX.



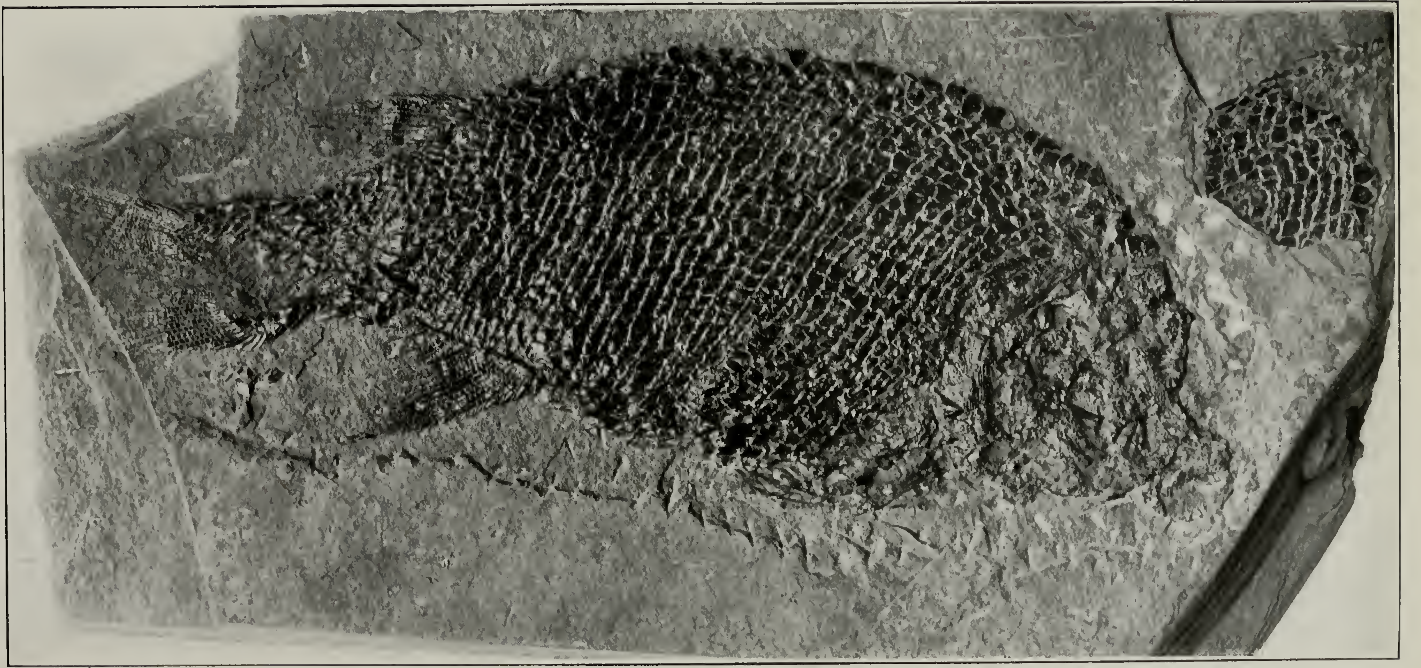
*Catopterus gracilis* J. H. Redfield. Trias; Sawmill Hollow, four miles southwest of Middletown, Connecticut. Cotype.
Original in Peabody Museum of Yale University. × $\frac{5}{6}$.

# PLATE X.



*Catopterus gracilis* J. H. Redfield. Trias (Posterior shale); Durham, Connecticut. Nearly complete fish, the only one of this species yet discovered in the uppermost horizon of the Durham section. The whitish appearance of the scales is due to mineral replacement resulting from chemical action upon the enclosing shale. Original collected by S. Ward Loper, and now in the Muesum of Wesleyan University. × $\frac{3}{4}$.

## PLATE XI.



*Catopterus gracilis* J. H. Redfield. Trias; Durham, Connecticut. Original collected by S. Ward Loper, and now in the Peabody Museum of Wesleyan University. × $\frac{7}{8}$.

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# State of Connecticut

State Geological and Natural History Survey

BULLETIN No. 19

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# ECHINODERMS
# OF
# CONNECTICUT

By
WESLEY ROSWELL COE, Ph.D.
Professor of Biology, Sheffield Scientific School
of Yale University

# BULLETINS

OF THE

# State Geological and Natural History Survey of Connecticut.

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.
2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.
3. A preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.
4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.
5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.
6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.
7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory and Henry Hollister Robinson.
8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.
9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.
10. A preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn and Lucia Washburn (Hazen) Webster.
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16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part I. General Introduction: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

18. Triassic Fishes of Connecticut: by Charles Rochester Eastman.

19. Echinoderms of Connecticut: by Wesley Roscoe Coe.

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## BULLETIN No. 19

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# Echinoderms of Connecticut

By
WESLEY ROSWELL COE, Ph.D.
Professor of Biology, Sheffield Scientific School
of
Yale University

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# Preface

In the preparation of this report on the Echinoderms to be found in that part of Long Island Sound which borders the Connecticut coast line the writer has been influenced by two incentives: first, to aid in arousing an interest in the study of a most remarkable group of animals of common occurrence; and, second, to aid in the dissemination of useful knowledge of the structure and habits of the starfish — the deadliest of foes to the oyster, which constitutes one of the state's valuable natural resources, and with which a large and important industry is connected. With these ends in view, an attempt has been made to furnish such adequate illustrations of each of the species of Echinoderms found in the waters of the state as will facilitate their easy recognition, while the economic importance of the starfish has been as fully investigated as the conditions would permit.

Free use has been made of the many excellent treatises on the animals concerned; and grateful acknowledgment is made to Professor A. E. Verrill, of Yale University, for the use of specimens and photographs; to Professor Hubert Lyman Clark, of the Museum of Comparative Zoölogy, Harvard University, for the use of a number of the photographs which illustrate his excellent report on the Echinoderms of the Woods Hole region; and to Mr. Davenport Hooker and Mr. Stanley C. Ball, for assistance in the preparation of the illustrations.

In the bibliography at the end of the report will be found a list of some of the most useful publications on our native species of Echinoderms, including those on the economic importance of the starfish.

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# ECHINODERMS OF CONNECTICUT

## INTRODUCTION

Among the natural objects most likely to attract the attention of the visitor to the seashore, particularly if the coast be somewhat rocky, are the five-pointed star-shaped creatures known as starfish. These are often found abundantly clinging to the rocks and seaweeds when the tide is low.

Among the seaweeds below the reach of the tides are somewhat similar animals, which have five slender, wriggling, snake-like arms, commonly known as serpent stars.

Just below the reach of the low tide also are other related animals, of rounded form, covered with coarse spines, which are commonly known as sea-urchins.

And, finally, when digging in the sand between tides, one may encounter pink or whitish worm-like animals, without distinct appendages to the body, but which nevertheless are able to cling to the hand; and these may belong to the group of animals known as sea-cucumbers, although our native species have little resemblance to the vegetable from which they take their popular name.

These four classes of animals occur abundantly along the shores of Long Island Sound, and careful search and critical examination will reveal the fact that there are several species of each.

All these animals belong to the division of the animal kingdom known to zoölogists as *Echinoderms;* for, although the starfish, sea-urchin, serpent star, and sea-cucumber may seem at first glance to differ from each other about as widely as any animals can, yet a careful study of their internal anatomy shows that all are built upon the same general structural plan. They furthermore have in general a similar embryology and life history. Hence the zoölogist and evolutionist believe that they are all related to each other, and have no hesitation in placing them together in a single group, or phylum, known technically as the *Echinodermata.*

These Echinoderms may be distinguished from other animals by certain well marked characters. As the name implies, the skin in most forms is provided with calcareous spines which project out from all sides of the body. Such spines are wanting however in the sea-cucumbers. Other calcareous plates are found in the skin. In most forms such plates unite to make a more or less complete shell which serves to protect the delicate internal organs. Most of them have likewise a distinct radial symmetry, in that similar parts are repeated around the central axis, as illustrated by the arms of the starfish or serpent star. With few exceptions they have a well developed water-vascular system, consisting of a circular canal around the mouth, with radial branches leading out to the periphery of the body. From the radial canals numerous branches lead out into the skin in certain regions of the body, and grow out into delicate tubular or finger-like projections.

These delicate projections are variously modified in different parts of the body for the performance of certain special functions. In all cases they serve as sense organs and as respiratory organs. If they have no further function they are known as tentacles; but in many cases they serve also in the locomotion of the body, and are variously known as tube-feet, sucker-feet, or pedicels.

These animals are found only in salt water, with the exception of one or more tropical species which are able to live in brackish water.

## CLASSIFICATION

All the Echinoderms of the world are divided by zoölogists into two sub-phyla, only one of which, the *Eleutherozoa*, is represented in our local fauna.*

The Eleutherozoa are divided into four classes, all of which have representatives living in Connecticut waters.

Class I. *Asteroidea:* Starfishes.— The body consists of a central disk which passes without sharp demarcation into five or more symmetrically arranged arms or rays (Plate I). The large mouth occupies the center of the disk on the ventral, or oral surface, while the minute anus is situated opposite, that is, on the aboral side of the disk. The arms are without joints. A deep groove on the oral side of each arm is thickly covered with tube-feet which serve to move the animal from place to place.

In Long Island Sound occur four species of this class, each of which has five arms. They comprise the common starfish (*Asterias forbesi*), the northern starfish (*Asterias vulgaris*),

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* The second sub-phylum, *Pelmatozoa*, which includes the *Crinoidea*, or Feather-stars, is represented in deep water as far north as off the coast of Maine by a species known as *Antedon dentatus*, but this has not been recorded from Long Island Sound. Farther south, and particularly in very deep water, occur other species, including some of the beautiful "sea lilies."

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Explanation of Plate I. Structure of Starfish and Ophiuran.

Fig. 1. *Henricia sanguinolenta.* Aboral surface of slender-armed specimen. (Natural size.)

Fig. 2. Same species. Oral surface of broad-armed specimen. (Natural size.)

Fig. 3. Same species. Portion of oral surface of disk and one arm, to show mouth, ambulacral groove, with the two rows of tube-feet, and spines. (Five times natural size.)

Fig. 4. *Asterias forbesi.* Small portion of aboral surface, showing the blunt spines surrounded by circles of pedicellariæ, and between the spines the closely-placed conical or tubular branchiæ. (Much enlarged.)

Fig. 5. *Ophiura brevispina.* Aboral surface. (Natural size.)

(Figs. 1, 2, and 5 from photographs loaned by the U. S. Fish Commission with permission of Dr. H. L. Clark.)

the slender-armed starfish (*Asterias tenera*) and the blood starfish (*Henricia sanguinolenta*).

Class 2. *Ophiuroidea:* Ophiurans, Serpent Stars, or Brittle Stars.— In these forms the body consists of a flattened, circular central disk, from the under side of which the usually slender, round arms, with a large number of movable joints, extend radially. These arms are sharply marked off from the disk (Plate I), and are provided with strong muscles, which enable them to be moved in nearly all directions and to be bent in sinuous or serpentine lines. By the movements of these arms the body is carried rapidly from place to place, and the flexibility of the arms enable the animal to hide away in a very narrow crevice. The mouth is situated as in the starfish, but there is no intestinal opening.

The ophiurans are represented in Long Island Sound by five species, only two of which occur abundantly. They comprise the following: the green serpent star (*Ophiura brevispina*), the daisy serpent star (*Ophiopholis aculeata*), the small gray serpent star (*Amphipholis squamata*), and the less common species, known as *Amphioplus abditus,* and *Amphioplus macilentus.*

Class 3. *Echinoidea:* Echinoids, or Sea-urchins.— Body nearly circular in outline, hemispherical, or flattened and discoid; without projecting arms. The calcareous plates in the skin form a compact encasement for the body except in the mouth region. The case is called the shell or, more properly, the test. The mouth is usually in the middle of the oral surface. The ambulacral areas, with numerous sucker-feet, in the more typical forms, extend around the body as meridians from the mouth nearly to the opposite pole. The spines are movably articulated with the plates on which they rest.

In Long Island Sound there are four species of echinoids, which differ so widely in general appearance as to be easily distinguished. The common purple sea-urchin (*Arbacia punctulata*) has a hemispherical test, with long, dark, reddish or purple spines. The green sea-urchin (*Strongylocentrotus dröbachiensis*) has shorter spines of a greenish color. The common sand-dollar (*Echinarachnius parma*) is very flat and covered with minute brownish spines. The key-hole urchin (*Mellita pentapora*) is likewise discoid, and covered with minute brownish spines; but is easily recognized by having five large openings, called lunules, which pass quite through the body from one surface to the other.

Class 4. *Holothuroidea:* Holothurians, or Sea-cucumbers.—The members of this group differ widely in general appearance from those of the other classes. Our native species all live beneath stones or burrow in the sand or mud. Their bodies are cylindrical and elongated, presenting a closer superficial resemblance to worms than to any of the other groups of Echinoderms. This worm-like appearance is greatly enhanced by the absence of any closely connected skeletal structures, and by the soft, bag-like, highly muscular skin. The skin has, however, isolated calcareous plates, often of such peculiar and definite shapes that the species are easily recognized by even a single plate. The mouth is situated at one end of the body, and is surrounded by a circle of branched tentacles. The anus is at the opposite end of the body. The animals move both by means of sucker-feet and by worm-like contractions of the body.

In Long Island Sound there are probably six species belonging to this class, although only four of these have as yet been recorded from Connecticut waters. The common *Thyone* (*Thyone briareus*) lies buried in soft mud in shallow water in great numbers in certain localities. Sometimes the animals have only the posterior end of the body projecting above the surface of the mud, but at other times they show also the anterior end with its circle of branched tentacles of black or purple color. The two other species of *Thyone, T. unisemita* and *T. scabra* are rare, and occur only in rather deep water.

Our fauna includes also two species with very slender bodies belonging to the genus *Synapta.* These are peculiar in having calcareous plates in the form of perfectly shaped anchors imbedded with other plates in the skin. *Synapta inhærens* is white in color, while *Synapta roseola* is pink or reddish. Both live in sandy localities between tides.

Finally, there is the beautiful sea-cucumber (*Cucumaria pulcherrima*), which is rarely seen alive, but specimens of which are sometimes thrown up on the beach by the waves following a storm. Little is known of its habits, but it is thought to live buried in the sand below low-water mark. It is short and thick, with firm body walls of a whitish color, and has peculiar plates in the skin.

The species enumerated above comprise all the Echinoderms known to occur in Long Island Sound, although the biological survey of these waters is far from complete. It is quite probable that future investigations will reveal the presence of additional species. The fauna of the eastern portion of the Sound includes more species than that of the western portion, because of its more varied physical conditions and its immediate connection with the Atlantic sea bottom.

Although the Echinoderms of this region are of no value commercially, they are of great economic importance because of the enormous injury which results from the depredations of the common starfish on the oyster beds. The members of the other classes feed mainly on seaweeds, minute organisms, and organic matter found upon the rocks and in the mud and sand between tides and covering the floor of the sea. They are therefore quite harmless to human interests, and are of some economic value in that they furnish a portion of the food supply of some of our edible fishes. Although covered with so firm an armor of defensive plates and spines, such species as the sand-dollar (*Echinarachnius parma*), the key-hole urchin (*Mellita pentapora*), and the species of serpent stars are nevertheless greedily devoured by the cod and other fishes. The holothurians with their less formidable plates are seized by various species of fishes, dragged from their burrows, and devoured. In their larval stages, too, the Echinoderms of all classes are eaten in enormous numbers by the surface fishes. It is however difficult to estimate the actual importance of these animals in respect to the human food supply.

The various groups of Echinoderms are likewise of great scientific interest, because of their remarkable anatomical structure, their peculiar modes of development, and their curious habits. No other group of the animal kingdom illustrates more clearly the modifications which the same organ-system can undergo in its adaptations to a great variety of functions. The evidence as to the relationships of the present-day Echinoderms, supported by an abundance of paleontological material, furnishes one of the best proofs of evolution.

Specimens of all classes of Echinoderms may be preserved in 80 per-cent alcohol. Formalin should not be used unless absolutely necessary, and should then be replaced by alcohol as soon as possible. Starfishes, serpent stars, and sea-urchins may be narcotized by adding magnesium sulphate (Epsom salts) to the sea water in which they are placed, and then killed by short immersion in fresh water or weak alcohol. They should then be placed in 50 to 70 per-cent alcohol for a few hours, and afterward preserved in 80 per-cent alcohol. For the preservation of holothurians with their tentacles expanded, it may be necessary to add the magnesium sulphate to the sea water very gradually. Otherwise the animals may contract vigorously.

Starfishes, ophiuroids, and echinoids make useful specimens when carefully dried. But all such specimens should be killed as indicated and placed for a day or two in strong alcohol. They should then be dried thoroughly by artificial heat. To prevent future injury from insect pests it is desirable to add a very minute quantity of corrosive sublimate to the alcohol in which the specimens to be dried are first preserved. It must be remembered that corrosive sublimate is a most powerful poison and must be handled with very great care.

The general scope of this report does not admit of an extended account of the internal structure of the various species included. For those who desire to make a thorough study of the organs of the body cavity of these animals the detailed descriptions given in various handbooks and laboratory guides in zoölogy are available. In the following chapters, therefore, will be given only such descriptions of the external features and internal organs as are necessary for an understanding of the relationship of the various groups, their natural history, including habits and life history of the various species, and for the accurate determination of each species.

Under the description of the species, only those characters which serve to distinguish our native species or have a direct bearing on their mode of life will be mentioned. More detailed anatomical descriptions of most of the species may be found in a report by Hubert Lyman Clark, entitled, "The Echinoderms of the Woods Hole Region," published in 1904, in the Bulletin of the United States Fish Commission for 1902. Many of the species are described, with interesting observations on their natural history, in Verrill and Smith's report on the "Invertebrate Animals of Vineyard Sound and Adjacent Waters," published in 1874, in the Report of the Commissioner of Fish and Fisheries. Other papers, which deal with particular species or groups of species, are mentioned under the separate species, while some of the more general treatises on the Echinoderms are included in the Bibliography at the end of this report.

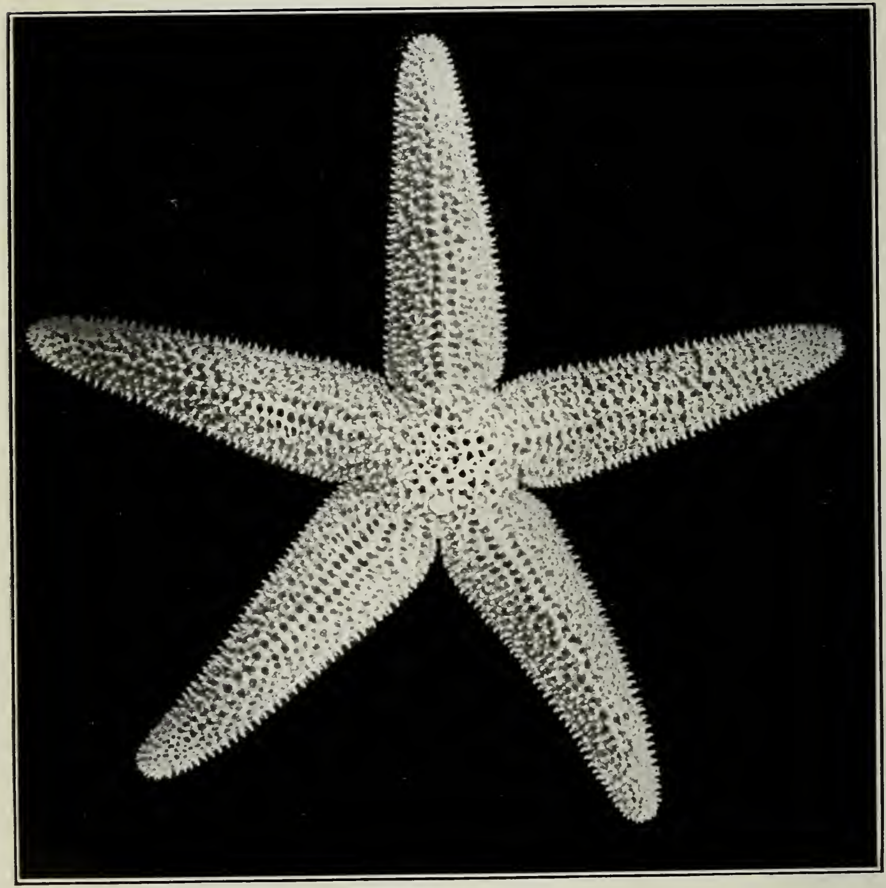

PLATE II. Skeleton of Starfish, *Asterias forbesi.* ( Natural size )

## CLASS I. ASTEROIDEA

The members of this group, popularly known as starfishes, are represented in Long Island Sound by three, or perhaps four, species, one of which is the commonest echinoderm found along the coast. They occur at all depths below low-water mark, and prefer rocky and shelly bottoms as a rule, because the mollusks which constitute a large part of their food are most abundant in such situations. They sometimes live on sandy, muddy, and gravelly bottoms, and are sometimes found adhering to piles of wharves. They are often found between tides, hiding beneath seaweeds or rocks in the tide pools, where they wait until the return of high water to resume their search for barnacles or mollusks adhering to the rocks.

All the species of starfish found in this region have normally five broad rays attached to a central disk (Plate II), although individual specimens having either more or less than this number are by no means rare. This variation in the number of rays is of much interest and is discussed in some detail on page 43. Along the northern coasts of New England lives a species which regularly has six rays and another which has ten; and in other parts of the world are species in which the number of rays increases with the growth of the animal until there may be as many as twenty to forty, or even more.

The starfishes creep slowly along by means of numerous tube-feet arranged in longitudinal rows on the under side of the rays. They can twist the flexible body and arms into almost every conceivable shape; and, if turned over, they can easily right themselves.

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Explanation of Plate II. Skeleton of Starfish, *Asterias forbesi.* (Natural size.)

Photograph of dried skeleton from aboral surface, showing the reticulated skeletal plates bearing conspicuous spines. The skin has been mostly removed. The madreporic plate appears as a circular white spot between the bases of the two lower arms, while the circle of six small spines just to the left of the center of the disk indicates the position of the intestinal opening.

Their rapidity of growth is largely dependent upon the abundance of their food supply. Very young starfishes may double their size within a few days when food is abundant. The older ones grow comparatively more slowly, but far more rapidly than was formerly supposed. The rate of growth of our common starfish is discussed on page 40.

The previous food supply has a great effect on the size of the animal when sexual maturity is reached, some individuals being several times the size of others at the first breeding season. After the discharge of the sexual products growth is resumed, and may continue year after year, the oldest animals being as a rule the largest.

When no food is to be obtained, however, the starfish can live for months without apparent loss of vitality, the size being somewhat decreased in the meantime.

## EXTERNAL STRUCTURE

The class Asteroidea, which comprises the starfishes, is distinguished from the other classes of Echinoderms by the presence of a central disk which merges gradually, without sharp demarcation, into the broad, radially arranged arms, or rays. The rays themselves are hollow, and contain portions of the digestive and reproductive systems and other organs.

The upper surface of disk and rays is termed the aboral, or abactinal surface, while the lower surface, having the mouth in the center of the disk, is the oral, or actinal, surface.

Between the bases of two of the rays on the aboral surface is situated a peculiar skeletal plate, the madreporic plate, or madreporite. In spite of its small size this plate is often conspicuous from the fact that it is of a different color from that of the adjacent surface of the body. If examined with a lens it may be seen to be pierced by numerous irregular openings, by means of which the sea water from the exterior may enter the water-vascular system (Plates II and III).

This madreporic plate may indicate the plane of symmetry in the body of the starfish, for a line passing through this plate and the axis of the ray opposite will divide the body into two nearly symmetrical portions, sometimes spoken of as right and

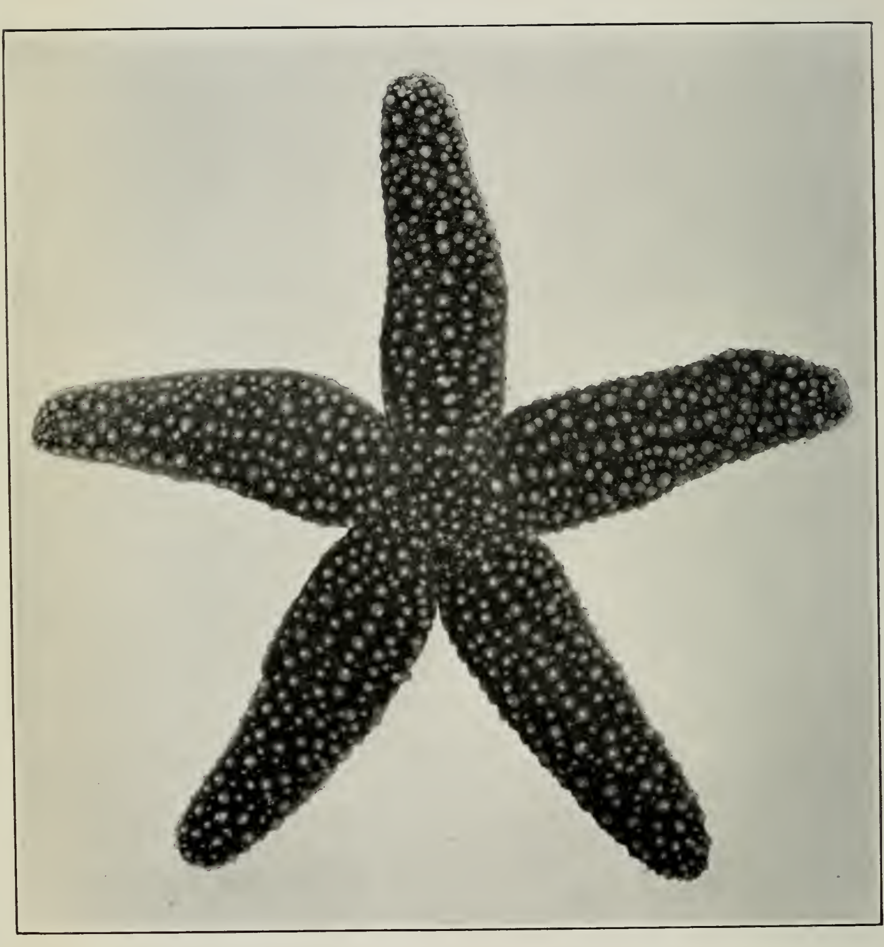

PLATE III. Aboral surface of Starfish, *Asterias forbesi*. Photograph of living animal. (Natural size.)

left. The two symmetrically placed rays adjacent to the madreporic plate constitute the bivium, while the three remaining rays form the trivium.

**Body Walls.** — The body walls, of both disk and arms, are supported by a network of articulating calcareous plates, or ossicles (Plates II and VIII), held together by connective tissue and muscular fibers. Imbedded in the body walls everywhere over the surface of the body are blunt calcareous spines, arranged in a more or less definite order, varying somewhat in different species, and often movable upon the underlying plates.

Covering the whole surface of the body, including even the spines and pedicellariæ, is a delicate membrane or skin, clothed externally with closely placed vibratile cilia (Plate III). The rapid vibration of these cilia keeps the sea water surrounding the body in constant motion.

**Branchiæ.** — In the smooth area between the spines the body wall is furnished with a multitude of protrusible filaments, the branchiæ (Plate I, fig. 4; Plate III), or respiratory processes, which have very thin walls and are filled with the fluid of the body cavity. When fully extended, an exchange of gases may occur between the contained cœlomic fluid and the external sea water, thus serving the purpose of respiration.

**Pedicellariæ.** — Scattered over the surface of the body in many species of starfishes, and arranged in groups at the bases of the spines (Plate III), occur great numbers of minute forceps-like or scissors-like appendages, called pedicellariæ. Each of these organs is provided with strong muscles which enable it to close tightly under the proper stimulus and thereby seize any tiny object with which it may come in contact. In the smaller pedicellariæ the two blades cross like a pair of scissors, while the others are like straight forceps (Fig. 8). By passing the objects from one to another, the pedicellariæ can by their united

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EXPLANATION OF PLATE III. Aboral surface of starfish, *Asterias forbesi.*

Photograph of living animal. (Natural size.) Each of the large, blunt spines is surrounded by a circle of tiny whitish pedicellariæ, while other pedicellariæ and numerous minute tubular branchiæ are scattered irregularly over the dark colored skin between the spines. The madreporic plate is seen as a dark, circular area between the bases of the two lower arms.

efforts remove any small foreign body from the surface of the disk or arm and thus serve to keep the body clean. They also serve to protect the delicate skin from attacks of such small enemies as might otherwise cause serious injuries.

In the blood starfish (*Henricia*) pedicellariæ are absent, the body in this instance being protected by the multitude of closely set spines (Plate I, figs. 1—3; Plate XI), which cover all parts of the aboral surface.

**Mouth.**— Turning now to the oral surface of the body, the mouth may be seen to occupy the central portion of the disk. Surrounding the mouth are five groups of movable spines (oral spines, or mouth papillæ), forming the five angles of the mouth (Plate VIII). By means of muscular contractions the oral spines may be brought together to close the mouth opening, or may be opened widely to allow the extrusion of the stomach, as indicated in the two photographs on Plate VIII.

**Tube-feet.** — Extending outward from the mouth are five deep grooves, the ambulacral grooves, one of which occupies the oral surface of each arm (Plate IV). In these grooves are situated the locomotor organs of the starfish, consisting of a multitude of finger-like sucking tubes — the tube-feet — arranged in definite rows throughout the length of the arm. In the species of *Asterias* (Plates IV and IX) there are four such rows of tube-feet, while in *Henricia* (Plates I and XI) there are but two. The rows are placed symmetrically on each side of the axial line, as shown in Fig. 2.

Each tube-foot consists of a muscular tube with a circular disk at the free end (Fig. 1). The tube leads between the ossicles forming the roof of the ambulacral groove, and connects internally with a sac-like swelling — the ampulla, — and also, by a narrow tube, with the radial canal of the water-vascular system. The relations of these parts are shown in Fig. 1.

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Plate IV. Oral surface of starfish, *Asterias forbesi*. (Natural size.)

The ambulacral grooves are widely opened, disclosing the four rows of crowded tube-feet, each with its terminal sucking disk. In the center of the disk appears the delicate, baglike stomach, partially everted, as in the beginning of the act of feeding. The photograph shows two rows of slender adambulacral spines along the borders of the ambulacral grooves, and the large blunt spines, surrounded by minute pedicellariæ, nearer the sides of the arms.

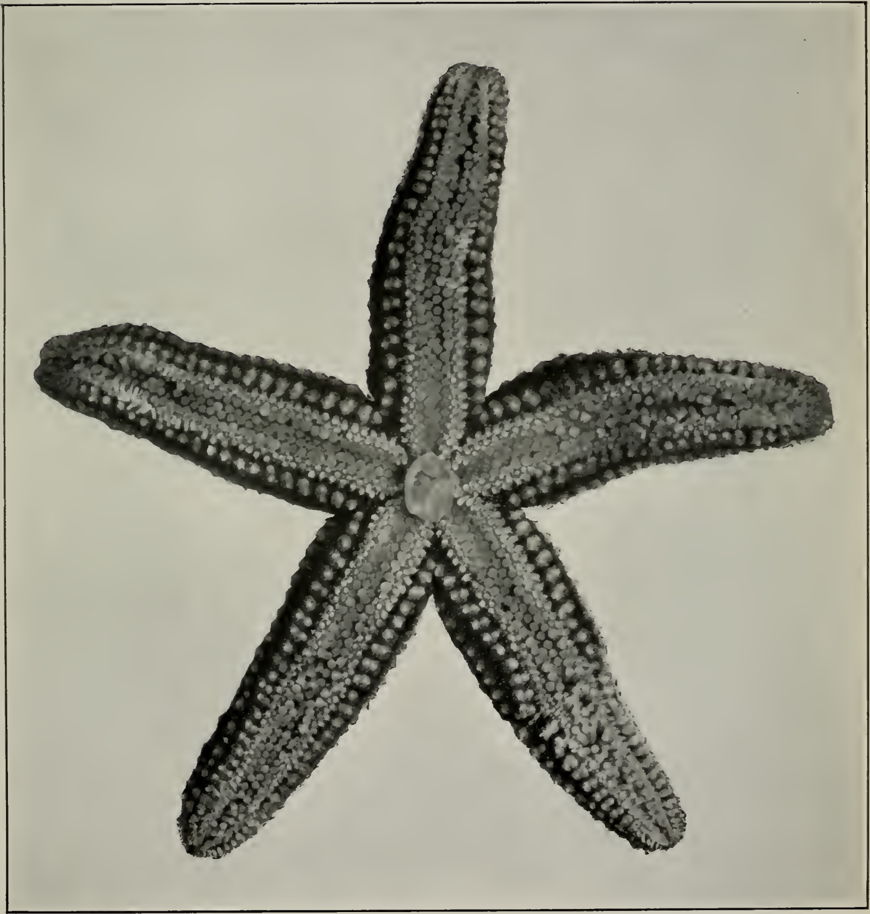

**PLATE IV.** Oral surface of Starfish, *Asterias forbesi.* (Natural size.)

Both ampullæ and tube-feet have highly muscular walls, and both are filled with fluid from the water-vascular system. When, in locomotion, the ampulla of any particular tube-foot is contracted, the fluid contained therein is forced into the tube-foot itself, extending this organ until it becomes a long, finger-like process. On coming in contact with any external object the disk at the end of the tube-foot may be pressed tightly against it. If now the muscles of the tube-foot contract, the water which

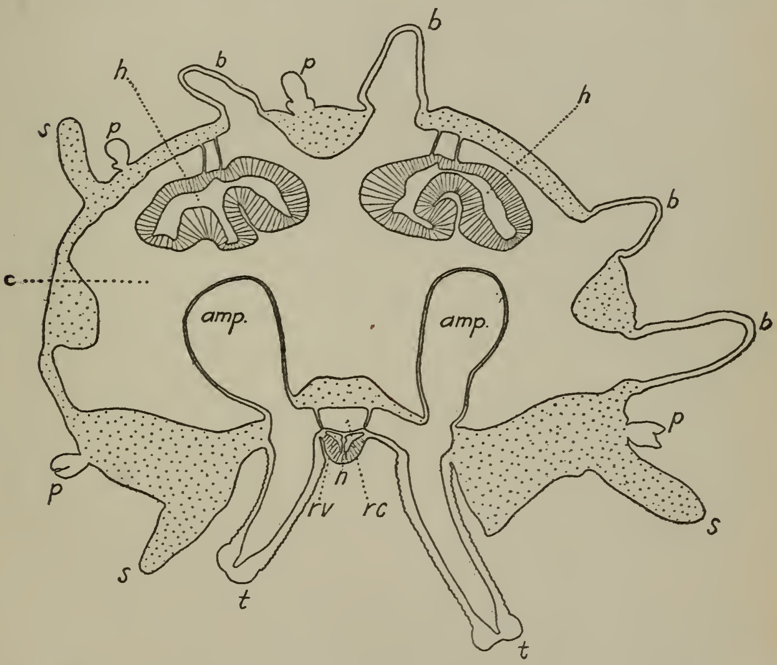

FIG. 1. Transverse section of a decalcified ray of a young starfish, showing the relations of the internal organs. The two ampullæ (*amp*) open by wide canals into the tube-feet (*t*), the water supply of which is provided by the radial canal (*rc*). The openings into the ampullæ from the radial canal are furnished with delicate valves, as indicated, which prevent the back flow of the water when the ampullæ are contracted and the tube-feet extended. Beneath the radial canal are the two radial perihæmal vessels (*rv*), separated by a vertical septum, and beneath these is the radial nerve-cord (*n*), which extends from the circum-oral nerve to the tip of the ray. Sections of the spines (*s*), branchiæ (*b*), and pedicellariæ (*p*) are indicated. The pyloric cæca (*h*) are attached by mesenteries to the dorsal wall of the ray. The spaces between the organs constitute the cœlom (*c*), and are in life filled with a fluid somewhat resembling the blood, and like it containing floating corpuscles.

it contains is returned to the ampulla, and at the same time the foot tends to shorten. As the terminal disk adheres to the external object by the pressure of the water, the shortening of the foot will tend to draw the body of the starfish towards the point of adhesion. If many such tube-feet work together, an actual movement of the body occurs. By the coördination of the nervous system of the animal all the tube-feet of any arm or of all the arms may be extended in the same direction, either to the right or left, backwards or forwards, as the case may be. The result is a slow, steady movement of the body.

Suitable muscular contractions of the other body muscles, combined with the working of the multitude of tube-feet, enable the animal to bring about a great variety of movements, by which it seeks its food, migrates from shallow to deep water or the reverse, rights itself when accidentally thrown upon its aboral surface, and forces apart the valves of the shells of the mollusks on which it feeds, as described on page 30. By such means, moreover, the starfish can so change the shape of its body as to occupy small crevices in the rocks, creep through small openings, and adapt itself to any surface with which it may come in contact.

**Ossicles.** — The roof of the ambulacral groove is formed by a series of interlocking movable plates, the ambulacral ossicles, arranged in a double row articulating with one another at the apex of the groove in such a way as to open or close the groove when required (Plate VIII).

On each border of the ambulacral grooves is a regularly arranged row of plates, adambulacral ossicles, which bear the adambulacral spines (Plate VIII). These spines may all be turned toward the middle line of the groove in such a way as to form a protection for the tube-feet.

The two rows of ambulacral ossicles end in a single terminal ossicle at the tip of the arm. This ossicle supports a terminal tentacle, endowed with a sensory function, presumably both tactile and olfactory in nature. At the base of the tentacle the radial nerve ends in a minute, orange-colored, eye-spot.

Between the ambulacral ossicles are the pores by which each of the tube-feet is connected with the corresponding ampulla, situated internal to the ossicle. The firmly interlocking ossicles

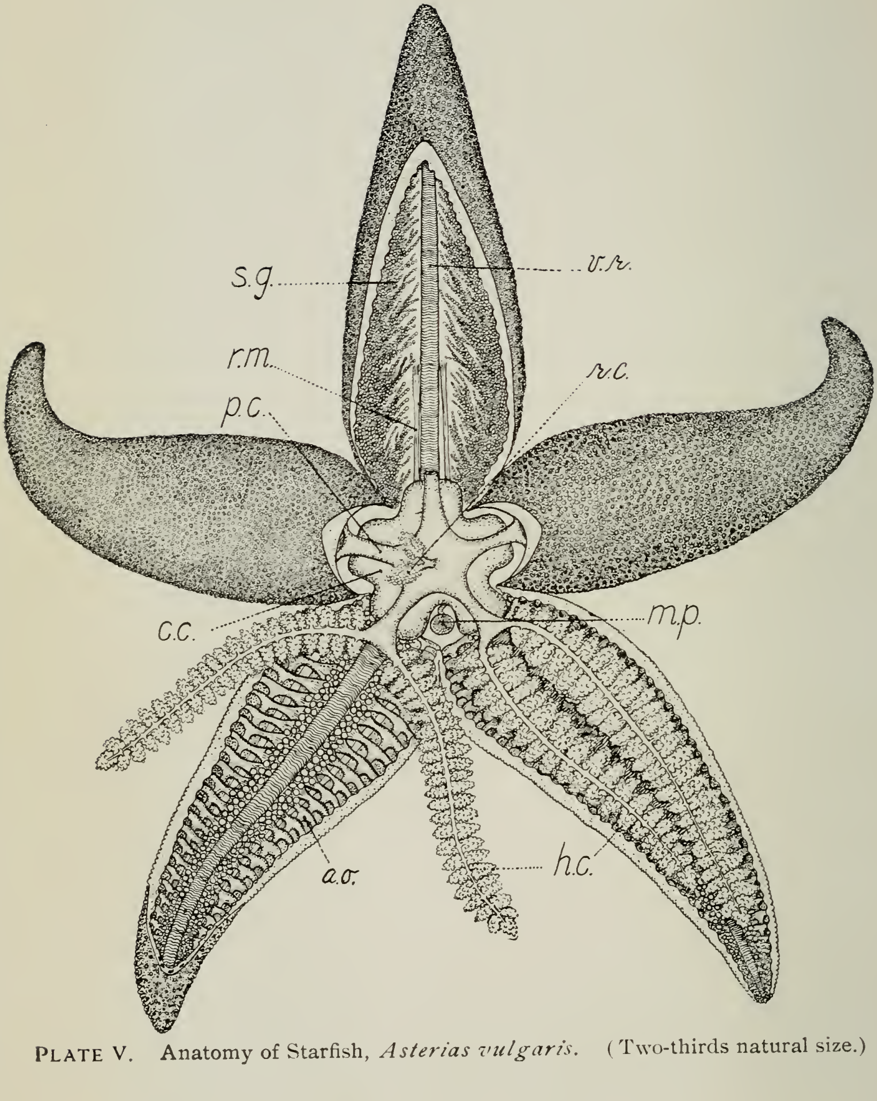
s.g.
v.r.
r.m.
r.c.
p.c.
c.c.
m.p.
a.o.
h.c.

PLATE V. Anatomy of Starfish, *Asterias vulgaris*. (Two-thirds natural size.)

which form the skeleton of aboral and lateral surfaces of the disk and arms are shown in Plate II.

## INTERNAL STRUCTURE

If the body of a starfish be opened by removing with fine scissors the body walls of the aboral surface of the disk and one or more arms, as indicated in Plate V, the internal organs are easily exposed. The most conspicuous viscera are the various portions of the digestive system, and, in certain seasons of the year, the reproductive organs.

In the dissection shown on Plate V, the five cardiac pouches of the stomach (*c. c*) lie beneath the five-lobed pylorus (*p. c*), into which open the profusely branched digestive glands, pyloric, or hepatic, cæca (*h. c*). The madreporic plate (*m. p*), rectal cæca (*r. c*), ambulacral braces (*a. o*), retractor muscles of stomach (*r. m*), vertebral ridge (*v. r*) and sexual glands (*s. g*) are shown. In the lower left-hand ray the pyloric cæca are laid aside and the sexual glands removed to show the ampullæ of the tube-feet on each side of the vertebral ridge. In the median ray the hepatic cæca are removed completely to show the position and extent of the sexual glands (*s. g*).

**Alimentary Canal.** — The digestive system of the starfish is modified to conform with the general shape of the body. The small, centrally placed mouth leads by a short esophagus into the spacious cardiac portion of the stomach. The latter is provided with five broad lobes, cardiac pouches, opposite the bases of the five arms (Plate V). The walls are very thin, much folded, and muscular, so that this portion of the stomach can be completely everted from the mouth opening and wrapped around such food as the animal secures. After the prey has been

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Explanation of Plate V. Anatomy of starfish, *Asterias vulgaris.* (Two-thirds natural size.)

Dissection from aboral surface to show internal anatomy; *a. o,* ambulacral braces; *c. c,* cardiac portion of stomach; *h. c,* hepatic cæca; *m. p,* madreporic plate; *p. c,* pylorus; *r. c,* rectal cæca; *r. m,* retractor muscle; *s. g,* sexual glands; *v. r,* vertebral ridge.

The lower right ray shows the viscera in their natural position. In the lower left ray the sexual glands and retractor muscles have been removed and the hepatic cæca separated to show the ambulacral ossicles and ampullæ of tube-feet. In the upper ray the hepatic cæca have been removed.

completely digested, the stomach is again drawn back into the body cavity by means of five pairs of long retractor muscles, which are attached to the upper side of the ambulacral ossicles in the rays, as shown in Plate V.

At its aboral end the cardiac stomach is constricted and leads into a narrower cavity, the pylorus, from which five pairs of large, profusely branched pyloric, or hepatic, cæca (Plate V) extend outward into the cavities of the rays. These cæca form the digestive fluids, which are able to act on fats, proteids, and carbohydrates. From the pylorus a short and narrow intestine (Plate V) leads to a minute anal opening on the aboral surface near the center of the disk, and on a line between the bases of the left and middle rays of the trivium. Connected with the intestine are two small glands, the rectal cæca (Plate V), which doubtless excrete waste products, to be discharged from the body through the anus.

As stated on page 32, whenever any considerable amount of refuse remains after digestion such substances are thrown out of the mouth. Consequently the intestine has little use except as an excretory organ.

**Water-vascular System.** — The complex system of vessels constituting the water-vascular, or ambulacral, system are of great importance in the locomotion of the body, as described above under the heading, "Tube-feet."

The madreporic plate serves as a sieve (*m*, Fig. 2) through which the external sea water enters the water-vascular system. This plate connects with the madreporic canal (the so-called stone canal), which leads into a large circular vessel surrounding the mouth. From this vessel a large radial vessel runs along the roof of the ambulacral groove to the tip of each arm. The radial vessel gives off paired lateral branches to the tube-feet (Fig. 2). The latter are all arranged in two rows on each side, and those of the two rows alternate. Consequently longer and shorter lateral branches alternate. The action of these tube-feet in locomotion is explained on page 23. Connected with the internal border of the circular vessel is a series of nine glandular sacs known as Tiedemann's bodies, shown in the diagram (Fig. 2). These sacs give rise to amœbocytes, or cells which float about in the fluid of the water-vascular system. They probably serve an important function in the collection and discharge of the waste products of the body.

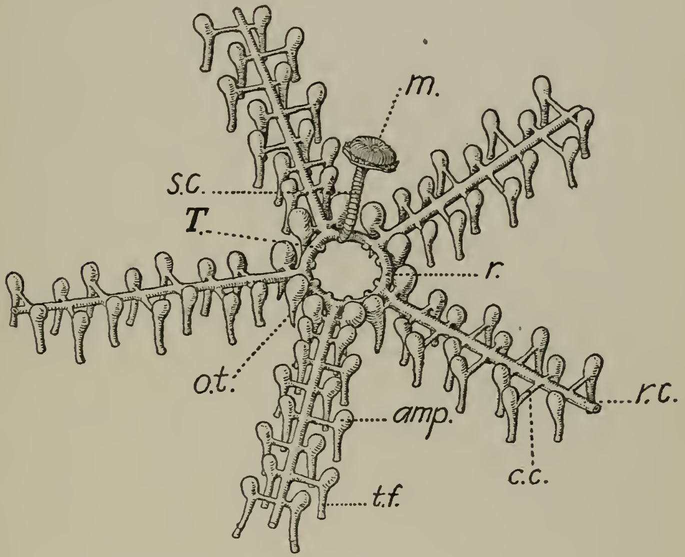

FIG. 2. Diagram of water-vascular system of starfish; *m*, madreporic plate; *s. c*, stone canal; *T*, Tiedemann's body; *o. t*, oral tentacle; *t. f*, tube-foot; *amp*, ampulla; *r. c*, radical canal; *c. c*, connecting canal; *r*, ring canal.

**Circulatory System.** — A complex system of vessels running parallel with the vessels of the water-vascular system is termed the perihæmal system. The principal vessels of this system are divided into two parallel chambers by a vertical septum. In the septum is a smaller central canal which contains a small amount of fluid, and is thought to constitute the true blood system. This latter has therefore radial and circular canals, parallel both to the water-vascular and to the perihæmal system. The radial vessels are shown in section in Fig. 1.

**Nervous System.** — The nervous system consists of a nerve ring surrounding the mouth, with a large radial nerve extending outward along the roof of the ambulacral groove of each arm and terminating in an orange-colored eye-spot at the tip of the arm. From the radial nerves minute branches are given off to each tube-foot and ampulla, to the superficial integument, and to the muscles and organs in the body walls. In addition to these main nerves is a complex network of fibers supplying the alimentary canal and other internal organs. Everywhere over the surface of the body is a network of minute fibers connected with the sense organs, pedicellariæ, and branchiæ of the integument.

The whole nervous system controls the coördinated actions of all parts of the body only when the connection with the nerve ring is intact. If the radial nerve at the base of one or more of the arms is cut, each arm so isolated from the nerve ring will act independently of all the others, and no coördinated movements of the body are possible. The nerve ring may therefore be looked upon as the coördinating center of the nervous system of this animal.

**Reproductive System.**— The sexes are separate, with paired sexual glands extending into each arm. These glands develop in close connection with the madreporic canal in a mass of tissue known as the axial organ. The development of the sexual products is described in detail in the chapter on reproduction.

## HABITS

Many interesting papers have been published in recent years describing in great detail the habits of various species of starfish and their responses to stimuli. In addition to the classical works of Romanes* and Preyer,† the papers of Cole,§ Cowles,¶ Jennings,** von Uexküll†† and others discuss the behavior of these animals when subjected to a great variety of conditions.

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* In addition to several more technical papers, the book entitled, "Jellyfish, Starfish, and Sea-urchins," published in the International Scientific Series, 1885, contains a most interesting popular account of the natural history of the starfish.

† Ueber die Bewegungen der Seesterne. *Mitteilungen aus der Zool. Station zu Neapel,* Band 7, 1887.

§ Cole, L. J., Direction of Locomotion of the Starfish (*Asterias forbesii*). Published in *Science,* vol. xxxi, 1910. This paper consists of a brief statistical study of the direction of movement of our common starfish in the absence of directive stimuli.

¶ Cowles, R. P., Reaction to Light and other Points in the Behavior of the Starfish. In Publication No. 132, Carnegie Institution, Washington, 1909. Describes the reactions of two species of starfish when subjected to various kinds of light.

** Jennings, H. S., Behavior of the Starfish *Asterias forreri* de Loriol. In the University of California Publications in Zoölogy, vol. iv, 1907. Observations on the habits of a species of Pacific Coast starfish and its reactions to various kinds of stimuli.

†† In addition to several technical papers by von Uexküll, a popular account of the general behavior of the starfish is contained in his recent book entitled, "Umwelt und Innenwelt der Tiere."

The general mode of life of the starfish, including habitat, locomotion, changes in shape of body, and migration, are briefly discussed in the following chapters, and the nature of this Report does not justify further details. The subject of habit formation, however, as described by Jennings* may be briefly outlined here.

"The behavior of the starfish is in general characterized by what might be called versatility; the animal can do in many different ways anything that it can do at all." In its locomotion, for example, it may move with equal facility in any direction along the plane of its body without any regard to right or left, or forwards or backwards. Under the same conditions its behavior is subject to the greatest variations, and it may be said never to do the same thing twice in exactly the same way.

When subjected to experiment it was found to solve the problem set for it, such as escaping from cramped quarters, removing rubber bands from its rays, etc., in a great number of different ways on successive occasions. But whenever left to itself it showed no improvement in solving these problems. It never learned to select the most effective method; that is, it failed to form the habit of employing this method when confronted again with the same problem.

But attempts to train the starfish were not altogether unsuccessful; for example, when placed on its aboral surface, the animal may right itself by employing any two adjacent arms, different pairs being used on successive occasions. Yet by preventing the use of certain arms the animal may be successfully trained to use certain other arms on all occasions. But the effects of this training are soon lost, so that on the following day the starfish shows no effect of its training. By giving the animal ten lessons a day for eighteen days, however, the starfish may show the effect for at least a week. By long continued training it is probable that still more lasting habits might be induced.

## FOOD

One of the species of asteroids occurring in Connecticut waters, the common starfish (*Asterias forbesi*), causes a vast pecuniary loss each year because of the enormous numbers of oysters which it devours. The extent of this loss is difficult to estimate, and the reader is referred to page 33 for an account of the injuries thus caused.

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* Johns Hopkins Univ. Circulars, No. 3, 1907; also Univ. Calif. Publications in Zoölogy, vol. 4, 1907.

The most usual food for all the species consists of mollusks and crustaceans, of which the various species of mussels, the oyster, the two common species of clams, and barnacles, furnish the principal supply. Univalves, or sea snails, of various species, and other invertebrates, are devoured whenever they can be secured; and indeed almost any small animal when injured or dead may be eaten. The larger starfishes may even devour small individuals of the same or of different species. The common starfish is occasionally of actual benefit in that it devours the univalve known as the oyster drill (*Urosalpinx cinerea*), which is itself a serious enemy of the oyster. But it does this only when oysters or other bivalves are not obtainable.

The starfish secures its prey by seizing it with the tube-feet and then drawing it toward the mouth. The mouth, however, is itself of small size as compared with the body of the starfish, being only about one-fourth to three-eighths of an inch in diameter in a moderately large animal. Only objects of small size can therefore be taken directly into the stomach. If the prey be too large to pass the mouth, which is the case with the greater part of the food, the soft, sac-like stomach is everted from the mouth and wrapped around the prey, after which digestive fluids are poured out and digestion ensues. After the absorption of the nutritive substances contained in the body of the prey, the stomach is again drawn into the body of the starfish, by means of a special set of retractor muscles.

If a large bivalve be secured, as a large oyster, clam, or mussel, the shell must be opened before the food can be devoured. But it is obvious that the strength exerted by the tube-feet of the starfish will have little immediate effect on the powerful muscles which hold together, and close tightly, the two valves of a large oyster or quahog. Many theories have been proposed in the attempt to explain the process by which these mollusks are opened by the starfish. It was formerly thought that the starfish excreted a poison which found its way between the valves of the shell and finally stupefied the mollusk sufficiently for the valves to gape and allow the starfish to insert its stomach.

But experiments show that a mollusk taken away from a starfish which had opened it, soon regains its normal condition. Another theory was that the starfish wrapped its stomach about the mollusk's shell, depriving the animal of oxygen and effectually smothering it. But observation shows that such is not the case. Another theory that has been held is that an acid dissolves the edges of the shell, but no such acid is present. Others have believed that the edges of the shell are chipped sufficiently to allow the entrance of the starfish's stomach; and it is true that the delicate edges are often accidentally broken by the starfish, but such a shell can still be closed so tightly as to hold water.

Thus the problem remained unsolved until 1896, when the experiments of Schiemenz* showed that simply the long continued pull of the starfish's arms will eventually overcome the resistance of the adductor muscle which holds the two valves of the shell together. While the muscle can resist for a short time a very strong pull tending to separate the valves, the muscle eventually becomes fatigued, and relaxation allows the valves to gape. In the same way, if a sufficiently stout cord is tied around the foot of a large marine snail, a strong man is unable to pull it from the shell. Yet such a snail is unable to support its own weight, by the same muscles, for a long period. After being suspended for a time by the foot, the muscles become fatigued and relax, allowing the body and shell to hang loosely at the end of the fully extended foot.

Schiemenz demonstrated that the starfish was able to exert a pull of more than 1,300 grams, while it required a force of only 900 grams to fatigue the muscles of a large bivalve so that the shell would gape widely within a half-hour.

It is only necessary therefore for the starfish to grasp the oyster with the tube-feet of opposite arms attached to the valves, and then continue pulling in opposite directions until the mollusk's adductor muscle becomes sufficiently fatigued to allow the valve to open. But a considerable force is required in order to accomplish this, and it is only when the arms of the starfish are wrapped around the shell of the bivalve in such a manner that the tube-feet in the basal portions of the arms can pull at right angles to the valves that the shell can be opened. Thus a starfish finds it quite impossible to open a bivalve when held with its arms outstretched beween two glass plates, even when there is plenty of room for it to carry the bivalve about with it.

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* *Mitteilungen des deutschen Seefischervereins*, 1896.

After the resistance of the adductor muscle of the mollusk is completely overcome, the stomach of the starfish is turned out between the two valves of the shell, and the soft body of the mollusk is then digested as in the case of a smaller object, leaving nothing behind except the cleaned and empty shell. Sometimes two or more starfish participate in devouring a single large oyster.

The processes concerned in the digestion of a large mollusk are so complete in the starfish that little if any refuse remains. But in the case of animals sufficiently small to be taken directly into the stomach, through the mouth, the indigestible food remains are thrown out of the mouth again. For this reason the opening of the intestine on the aboral surface of the body is very small, and serves merely for the discharge of fluid waste materials secreted by the glands connected with it.

When food is abundant the starfish often devours an enormous quantity, and growth is correspondingly rapid. The observations of Mead, on the voraciousness of young starfish, as noted on page 57, show that as many as 56 clams, some of which were as long as an arm of the starfish, could be devoured by a single starfish within a period of six days.

On the other hand, in case food cannot be secured, the starfish is able to survive a fast of several months without apparent discomfort. In the latter case, however, no growth whatever occurs until food is again secured.

## NATURAL ENEMIES

It would seem that an animal so well protected by its spiny skin and abundant pedicellariæ, would be largely exempt from the attacks of other carnivorous animals of the sea. And in the adult condition such is actually the case. Occasionally one starfish when pressed with hunger will devour another of the same species; fishes of various kinds destroy mutilated individuals and probably large numbers of young. Various species of birds, as crows and gulls, which frequent the shore, sometimes feed upon the starfish when other food is difficult to obtain. The starfish is said also to suffer occasionally from the effects of a parasitic disease.

But the greatest destruction occurs in the very early stages in the life of the starfish, at the time when the bipinnariæ or brachiolariæ, as the embryos are termed, are swimming free at the surface of the water. At this time such fishes as the menhaden swim through the water with their mouths widely open and devour countless numbers of small organisms of all sorts from near the surface. Among these may be the young of two species of *Asterias*, and vast numbers are destroyed in this way. The young of *Henricia* develop directly from the egg, and thus escape the dangers of the free-swimming stage.

How does it happen, then, if there be so few natural enemies of the starfish after it has assumed the adult condition, that the sea is not overrun with the creatures to the exclusion of all other animals? Of the thousands of eggs laid by a female starfish each year not more than one on the average produces a sexually mature animal. All the others die; some are destroyed by the enemies indicated, many die from their inability to obtain food, others are buried beneath the mud of the bottom, some are crushed by the rolling pebbles on the shore, still others succumb to changes in the temperature of the water, many die from the effects of rain or streams of fresh water, while vast numbers are left by the tides to be destroyed by drying in the air.

As a result of these many hazards only a small fraction of one per cent. of the embryos survive to produce young starfishes a half-inch in diameter. The few that reach this stage of development are comparatively safe.

## DAMAGE TO OYSTERS AND OTHER MOLLUSKS

There is little realization except among the oyster planters themselves of the enormous extent to which the starfish is destructive to the oysters and clams which form such an important natural resource of the state. The oyster industry alone produces an annual income of over a million dollars, and furnishes employment to hundreds of citizens.

For the year ending June 30, 1910, the receipts in this state from the sale of market and seed oysters and shells was $1,892,759, while there remained on the beds in private areas alone an estimated quantity of 3,784,175 bushels of oysters, valued, with the stakes and buoys which mark the grounds, at $1,856,285. During this year the industry gave employment to 2,703 persons.*

For the mere privilege of controlling certain parts of the floor of the Sound for the cultivation of oysters, the oyster planters have paid over $260,000 into the treasuries of the state and the towns adjoining the coast.†

So serious is the starfish injury to the oyster industry that the General Assembly of this State, in 1901, passed a law making it illegal for any person to assist in the spread of the pest. The law reads as follows: "Every person who shall wilfully deposit or assist in depositing any starfish . . . . in any of the navigable waters of this State . . . . shall be fined not more than fifty dollars, or imprisoned not more than six months." (Connecticut Shell-fish Commissioners' Report for 1903, page xxvi.)

The actual loss which the starfish causes to the oyster industry of the state is very difficult to determine with any degree of precision. Any estimate even of the losses to a single grower is, from the very nature of the case, largely a matter of guess-work. Furthermore the natural beds suffer a great annual loss, of which no one takes account. The loss to the new set, when the individual is but a small fraction of an inch in diameter, may actually be, and probably often is, greater than that caused by the more conspicuous destruction of oysters of larger size. The oyster grower who watches his plantations carefully knows when the starfishes of larger size become numerous on his beds, but he has no means of determining the injuries caused by the young individuals to correspondingly young oysters. The fact that a single starfish less than a month old has been shown to be able to devour more than 50 young clams in six days, indicates how extensive these injuries may become.

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* Report to the General Assembly, State of Connecticut, on the Investigation of Oyster Properties by the Board of Equalization, 1910, page 77.

† Report Shell-fish Commissioners, 1907-08, page 82.

On the privately controlled beds regular examinations are made for the presence of the starfishes, and, whenever they are found in unusual abundance, it is imperative that immediate steps be taken to destroy them. This is accomplished by the use of mops, as described below, by means of which the larger starfishes are caught and killed.

By such thorough and regular inspection the very extensive injuries of former years have been largely controlled, and the oyster grower of to-day, like the fruit grower on the land, always reckons upon a certain expense for the destruction of pests.

The actual expense of this method of controlling the starfish varies somewhat from year to year; and, while an accurate estimate of the total amount is not available, it is known to be very great. And yet, as in the case of the fruit grower, it is but a fraction of the amount that would inevitably be lost if such measures were not taken.

During the year 1909, inquiry as to the number of starfish actually destroyed in carrying out this policy of protection shows that many thousand bushels of the pests are annually destroyed. When we consider the fact that each bushel will contain several hundred starfish, the number, of course, varying with the size, we may gain some conception of the vast number destroyed.

In reply to an inquiry, the following statements by a prominent oyster planter may be considered as expressing the most accurate information obtainable. "The starfish seem to vary in different localities from month to month, but the average on the whole seems to keep up remarkably high, considering the fact that such a vast quantity of these destructive creatures are caught by the oyster steamers." "We have not at command definite amounts that are caught per year, but in a general way would say that they probably run from 5,000 to 10,000 bushels per year. Some years they may exceed the latter figure."

The excessive abundance in restricted localities often occasions great alarm among the growers, but of late years success has invariably rewarded the determined effort to combat the pest upon any particular bed. Sometimes, however, it must be admitted that this result has been attended with very great expense.

Although it is probable that the injuries during recent years are on the whole less than in some former years, yet the total loss is still very great. In December, 1909, for example, the following item from a Rhode Island paper indicates that even during that year the damage in certain localities must have been excessive.

"The fishermen and oyster growers are complaining of the prevalence of starfish, which are doing great damage to the growing stock. Old oystermen say that never in the history of the business have the starfish been so plentiful, and many of the steamers in Cowesett bay and other points along the coast, which in ordinary seasons are engaged in dredging, are now dragging 'starfish mops' over the beds to get rid of the pest.

"One prominent oyster man says that the damage to the oyster beds in Rhode Island and Connecticut this season will be at least a quarter of a million dollars, when the loss of stock and the expense of catching and killing is taken in consideration. The growers are at a loss to explain the unprecedented increase of the pest other than last summer the weather conditions were right for breeding the fish. The expense of catching the starfish is practically so much money lost, as the stars are of little use except as fertilizer, and even for that purpose they do not command much in the way of price, as they are not caught in large quantities."

The point of view of the oyster planter is well expressed in the following statements by Mr. B. Frank Wood, Superintendent of Shell-fisheries of New York State.*

"In Long Island Sound, the starfish is the enemy most to be dreaded. The set of stars seems to have some relation to the oyster set, and, in seasons when the young oysters are abundant, the planters look for a like abundance of stars.

"This fish is certainly an ill and evil star to the oyster and to its cultivators. At times covering the bottom to a depth of eighteen or twenty inches and extending in solid bunches or masses over considerable areas of ground, they are capable of blanketing entire beds of oysters in their slow but sure advance, leaving not a living bivalve behind. They are very hardy and tenacious of life, and may even be deprived of some of their limbs or rays and regain these members by a new growth which makes good the loss. Unless these pests are constantly attacked in season and out of season, and their numbers reduced, they are sure to overwhelm and totally destroy the oyster beds. This refers particularly to shell-fish lands situated in Long Island Sound, for it is true that there are some localities where comparative freedom from the enemy is enjoyed.

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* Biennial Report of the Shell-fish Commissioners of Connecticut, 1907-08, pp. 96-99.

"Many devices have been invented and used for the purpose of destroying the stars. The one now in general use by the planters is the star-mop, or tangle. It is made of cotton cords or strings, arranged in large tassels or bunches, attached to a steel frame, and drawn over the beds by means of the dredging chains and machinery. The stars become entangled in the meshes of these mops and are raised in large numbers. Mr. Herman D. Pausch has made many experiments for the purpose of perfecting some better plan of combatting this scourge. He has found, he believes, a practicable method for use in localities where there is not too great depth of water. His plan is to make a continuous wall or ridge of lime along the boundary of the bed to be protected. He has accomplished this by filling paper bags with quicklime and dropping these bags along the line. The paper serves to hold the lime from being carried away by tides while descending through the water. The water will of course slack the lime, but Mr. Pausch states that so long as the lime barrier remains intact no starfish will cross it. He has experimented quite extensively in this direction, and is of the opinion that the results obtained will warrant the use of his methods upon a large scale. One of his tests consists of placing starfish within lime enclosures, and though kept there for considerable periods of time not one will attempt to cross the line which separates it from freedom.

"Mr. Pausch says that the lime barrier constitutes a veritable dead line for the sea-star. He considers the use of paper bags a somewhat clumsy plan for getting the lime to the bottom, and is now engaged in perfecting an apparatus by means of which he may feed the lime through a hose or pipe so drawn over the ground as to leave an unbroken ridge of the material on the bottom.

"The vast numbers with which the star overwhelms the shell-fish beds, taken in connection with his insatiable appetite, make it clear that nothing but eternal vigilance on the part of the planter will hold the day against him.

"There is, consequently, a community of interest among the planters, in attacking and destroying the star. For, in protecting his own beds, a man also assists his neighbor to whose tracts the stars might go, and, conversely, any neglect of one's own ground constitutes a menace to all cultivators in the vicinity.

"The work of destroying stars is a duty, as before intimated, in which the natural-growth oysterman usually takes no part. He takes the oyster where he can find it, appropriating the bounty of heaven without accepting any responsibility as to the conservation of a further supply."

Whenever the starfishes are found upon an oyster bed in excessive numbers, the oyster grower sends out his boats with the star-mops, or tangles, which are dragged back and forth systematically over the bed.

"When the star-mop is drawn to the surface, its load of stars is deposited in a vat or tank and treated with boiling water or live steam. The oyster boats are well equipped with apparatus for this purpose, the steam or water being conveniently taken from the vessel's boiler, though some of the steamers have special boilers for this purpose.

"Attempts have been made to turn to some useful purpose the large quantities of stars taken from the oyster beds of Long Island Sound, and it goes without saying that this should be a more or less valuable by-product of the industry. Properly mixed with other material, they constitute a valuable fertilizer. Frequently, farmers residing in the neighborhood of oyster planters have contracted for the catch of stars, but the oystermen say that in practice it does not work well, as they find that they cannot depend upon having the accumulation of dead stars regularly removed from their premises, and of course they cannot allow them to remain and putrefy. As a consequence, the usual mode of disposition is to throw them overboard after they have been killed in the live steam or boiling water bath."

A perusal of the Reports of the State Shell-fish Commissioners reveals many instances of the excessive losses caused by starfish in former years. In the report for 1883 the statement occurs that thousands of bushels of oysters were destroyed in one locality within a single week. A single firm lost $20,000 worth in one bed, while another firm suffered a loss of $100,000 in "the last two years."

The report for 1884 states that 11,000 bushels of the pests were caught off Stratford during a period of six weeks, but before the work was completed at least 200,000 bushels of oysters had been destroyed.

In a paper by Collins on the Oyster Fisheries of Connecticut, an estimate is made that in 1888 the damage to beds in Connecticut waters amounted to some $651,500. During that year 42,000 bushels of starfish were destroyed.

Appreciating the ability of the starfish to migrate from one spot to another not far removed, one enterprising firm of oyster growers has sometimes paid a dollar for each bushel of young starfish collected on the shores adjacent to their plantations. Such a procedure is doubtless profitable to all the parties concerned; for, when the young starfish are abundant, the dollar is easily earned, and the destruction of so large a number of small starfish as may be contained in a bushel basket — occasionally as many as 2,000 very small ones — will undoubtedly reduce the expense of protecting the beds by more than the sum expended.

Not only is there great destruction of oysters, but other mollusks of economic importance, as the clams and mussels, suffer, perhaps, to an even greater proportional extent. The mussel is one of the chief natural food supplies of the starfish, but, as this mollusk is little used commercially in Connecticut, the pecuniary loss is not of importance. The injury to the clam, on the other hand, which furnishes an important article of food, is a matter of some real concern to the people of the state. The barnacles, worms, crustacea, and various gastropod mullusks, from which the starfish derives a portion of its food supply, have little to do with human welfare; and, whenever the starfish supplements its diet by devouring one of its own kind, or when it feeds upon the mollusk known as the oyster drill, it becomes, for the time being, of distinct service. Likewise, in furnishing a portion of the food supply, either directly or indirectly, of certain fishes used for human food, it compensates to some slight extent for the damage which it causes.

## RATE OF GROWTH

The rapidity with which starfishes increase in size, and the age at which sexual maturity is attained, have long been subjects for discussion among zoölogists. A number of years ago Alexander Agassiz estimated the growth and age of the common starfish, and came to the conclusion that it required about fourteen years for the animal to reach its full development. It was thought to begin to spawn before that time, apparently at six or seven years of age.

Professor Mead, however, has settled this point beyond dispute* by actually rearing large numbers of young starfishes from the time when the free-swimming larvæ attach themselves to the eelgrass and other objects in preparation for their transformation to the adult form.

By keeping these young starfishes in aquaria and submerged cars and feeding them regularly, a most surprising rapidity of growth was found to result. On June 29th the stars measured on the average only about 1mm. from mouth to tip of arm; on July 18th, 5mm.; July 26th, 9mm.; August 18th, 18mm.; Sept. 26th, 35mm.; and on Oct. 25th, 54mm. Such stages of growth are represented in their natural size on Plate VI, from Mead's report in the Bulletin of the U. S. Fish Commission for 1899.

Figs. 1 to 3, on Plate VI, show small individuals taken from seaweed soon after having completed the free-swimming stage. Fig. 4 shows the average size found on eelgrass and seaweed about two weeks later, July 15, and Fig. 5 a large individual of the same age which was reared in a submerged car and well supplied with food. A similar individual reared in car, three days later, is shown in Fig. 6; and one after eight days more, July 26, in Fig. 7. Figs. 8, 9, and 10 indicate the size of the young starfishes about four weeks, six weeks, and nine weeks after having completed the free-swimming stage. Fig. 11 shows the growth in three weeks more, while Fig. 12 indicates the size attained by a large individual reared in submerged car with an abundance of food, at about 4 months of age.

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* Mead, A. D., On the Correlation between Growth and Food Supply in Starfish. *American Naturalist*, vol. xxxiv, 1900.

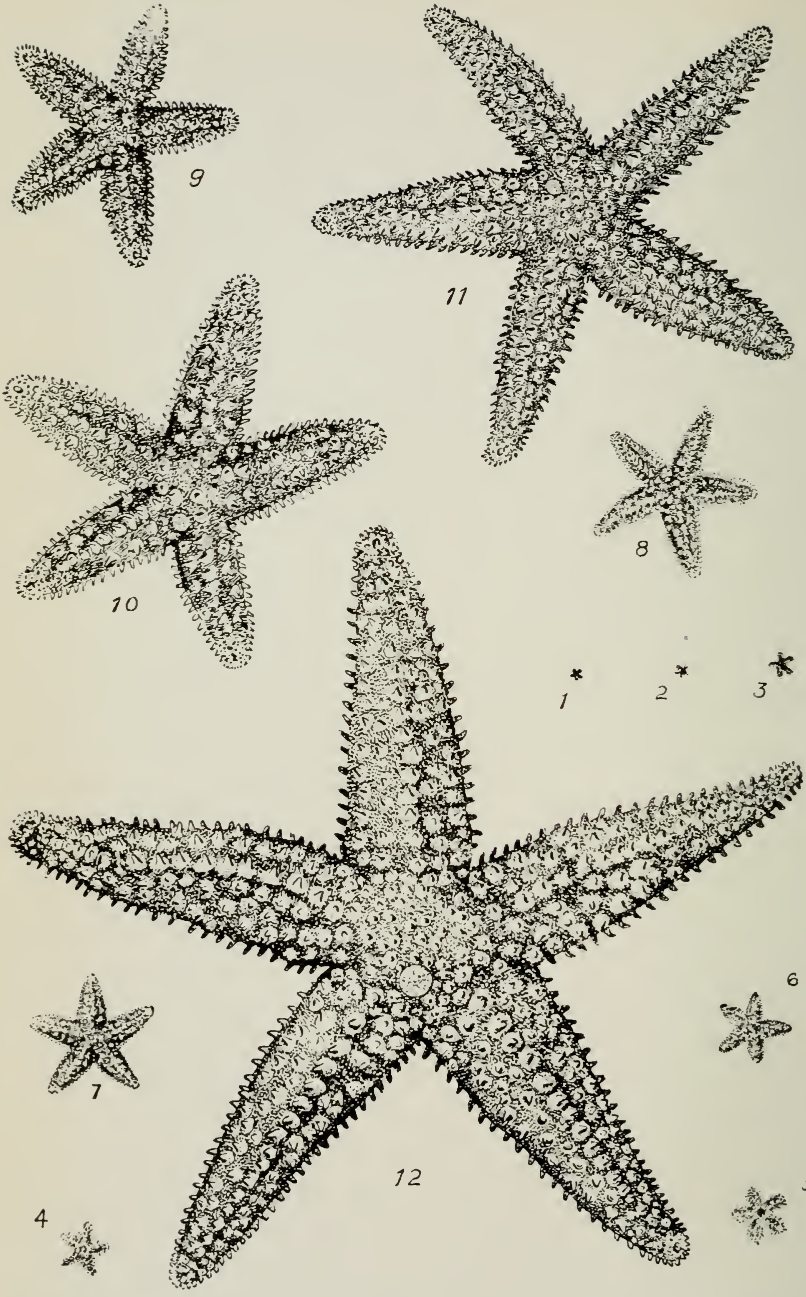
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PLATE VI. Growth of Starfish, *Asterias forbesi*, during the first four months of life. (Natural size.) After Mead.

There were larger specimens than those indicated, and also smaller, for at all times there were some individuals which were only a third as large as the others, and all intermediate stages occurred between the smallest and the largest. Similar series could be obtained along the seashore at any time during the summer and fall.

By varying the amount of food supplied, Professor Mead was able to prove that the rate of growth depended directly upon the amount of food available. In this respect the starfish behaves quite differently from the higher vertebrate animals, for the starfish can assimilate many times as much food as is necessary for keeping it in good condition, and all the food not required for the maintenance of the bodily functions is used in the manufacture of new tissues, whereby a rapid growth results. Yet a starfish will live and remain in apparent health for months with scarcely any food whatever, although no growth takes place under such circumstances.

When the usual food supply becomes scarce, the larger starfishes show no hesitation in devouring smaller individuals of their own kind.

In Fig. 3 are shown outlines of two individuals of the same age, five and one-half weeks, the small star on the left representing a starfish to which but little food was supplied, while the larger figure shows the size which a well nourished specimen may reach at the same age.

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EXPLANATION OF PLATE VI. Rate of growth of starfish, *Asterias forbesi.*

A series of young starfish to show the rate of growth of well-nourished individuals during the first four months of life. All natural size.

Figs. 1 to 3. Small individuals during the first week after having completed the free-swimming stage, July 1.
Fig. 4. Specimen from eelgrass two weeks later, July 15.
Fig. 5. Specimen reared in submerged car about three weeks after the completion of the free-swimming stage, July 15.
Fig. 6. Similar specimen three days later, July 18.
Fig. 7. Large specimen from car when one month old, July 26.
Fig. 8. Similar specimen on August 2.
Fig. 9. Similar specimen on August 18.
Fig. 10. Same on September 5.
Fig. 11. Same when three months old, September 26.
Fig. 12. Largest specimen reared in submerged car at the age of four months, October 25.

(After Mead.)

It is of interest to note that the loss of an arm does not cause even a temporary diminution in the rate of growth, the rest of the body increasing in size as rapidly as in the case of uninjured individuals. Even the loss of two arms has little effect. The lost arms are rapidly replaced if food is abundant, and in their regeneration grow faster than the others until the normal symmetry of the body is restored.

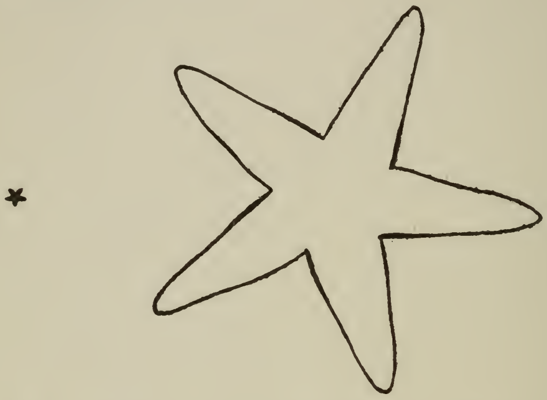

FIG. 3. Outlines of two starfishes of the same age (5½ weeks), showing difference in the rate of growth under the influence of different food supplies. (After Mead.)

The age at which the starfish becomes sexually mature is also influenced by the rate of growth, for Mead has found that all starfishes with a length of ray of more than 50 mm. at the beginning of the breeding season, in May, are sexually mature, while others, but 10 or 15 mm. long at the same date, do not deposit sexual products until the following year. Now the length of 50 mm. is reached by well nourished individuals when less than four months of age, so that it seems reasonable to conclude that the well fed starfishes are ready to breed when a little less than one year old; that is, in June of their first year.

The rate of growth is most rapid during the warmer months of the year, and may cease entirely during the winter. This is probably due in part to the smaller amount of food devoured, and in part to the development of the sexual products.

## MIGRATION

It is well known that when the food supply in one region is exhausted the starfishes migrate to other localities, and furthermore there is more or less regularly a seasonal migration from the tide pools along the shore to the deeper water. But the extent of such migrations has probably been greatly overestimated, and the sudden appearance of vast hordes in any particular spot is due more to the very rapid increase in the size of the small and previously unnoticed starfishes than to the actual migration of a multitude of individuals. If a starfish should move constantly in one direction at the rate of six inches per minute, which is about its normal rate of progress, it could travel about a mile per week; but there is no evidence that such a rate is maintained for more than a few minutes at a time, and it is probable that the creature is quite as likely to retrace its steps or to proceed in an irregular path as to continue for more than a few minutes in any single direction. As stated in the quotation on page 37, quicklime has proved an efficient barrier, although the animals can easily pass all kinds of soft or slippery substances.

## VARIATION IN NUMBER AND ARRANGEMENT OF RAYS

While all of our native species of starfish have normally five rays of nearly equal size, yet if one examines a large number of specimens he is likely to notice certain variations. In the common starfish, for example, careful search may reveal an individual with but a single well formed ray and other rudimentary ones, while another specimen may have as many as eight rays, all perfectly formed.

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Explanation of Plate VII. Variation, *Asterias forbesi.*

Fig. 1. Four-armed individual, showing no indication of injury.
Fig. 2. Eight-armed individual, provided with two madreporic plates.
Fig. 3. An individual in which one arm is forked or longitudinally divided nearly to the disk.
Fig. 4. Six-armed specimen.
Fig. 5. One with seven well formed arms.
Fig. 6. An individual in which an injury has removed all the arms of the disk except one, the four small arms being in process of regeneration.

(All figures two-thirds natural size.)

Professor Verrill, of Yale University, has made a large collection of these abnormal specimens, and has recently published* a paper on the subject. On Plate VII are shown a number of such specimens. Some of these are the result of injury, others may have arisen from congenital variation, while others evidently represent cases in which there has been a partial division of the body in an early stage of development. Fig. 2, for example, shows an individual which has eight perfectly formed rays, but this specimen is also provided with two madreporic plates. These facts would seem to indicate that in an early stage of development, perhaps even at the time of the first cleavage of the egg, the body became partially divided into two incomplete individuals. As development proceeded, these twins, as they may be called, remained attached together, each provided with four rays and the usual madreporic plate. A further and complete separation might result either in two normal individuals, identical twins, or in such specimens as the one shown in Fig. 1. On the other hand it seems possible that the four-rayed starfish of Fig. 1 may have resulted from an early injury and loss, without regeneration, of the missing arm; or as a so-called congenital variation, that is, one which has arisen very early in development, but of which the cause is not apparent. In Fig. 3 is shown an individual in which the arm opposite the madreporic plate is forked or split longitudinally from the tip nearly to the disk. This may be looked upon as a partial duplication or twinning of this ray, or possibly as the result of early injury.

Fig. 4 shows a variation in which there are six perfect rays, while in Fig. 5 there are seven. The six-rayed condition is much less rare than the other cases enumerated. From a great number of specimens which Professor Verrill has examined from near New Haven, Connecticut, 1 in about 2,000 has six rays, 1 in 3,000 has four rays, and 1 in 10,000 has seven or eight rays.† Some of these may be due to repairs of injuries received in early life, with development of extra rays.

The experimental studies of Dr. Helen D. King on the regenerative processes in *Asterias vulgaris*‡ indicate the manner

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***American Naturalist,* 1909.

† *Loc. cit.,* p. 546.

‡ *Archiv für Entwickelungsmechanik,* vol. ix, 1900.

in which such variations may be artificially produced. For if the disk of a starfish of this species be cut between the bases of two of the rays by an incision reaching from the border of the disk to the mouth, one or two new rays may sometimes be produced in the healing of the wound. Such supernumerary rays are at first smaller than the others, but it seems reasonable to assume that by the compensatory regulations of the body they might eventually become similar in all respects to the five original rays. Some of the six- and seven-rayed individuals of the common starfish may have resulted from similar wounds inflicted by fishes or by accident. In the removal of two or more rays, it sometimes happens that the number regenerated is one less than the normal. In this way a specimen like that shown in Fig. 1 may result.

In Fig. 6 is shown a specimen in which it is apparent that some injury has deprived the animal of all its rays except one; the four lost members are being regenerated in their normal positions about the disk. It is not at all unusual to find individuals which are thus replacing one or more rays which have been lost by an injury. Such regeneration can be studied experimentally in the laboratory, and is discussed in the following chapter.

Nevertheless it should be emphasized that, while certain species from other parts of the world naturally reproduce by spontaneous division, it is not believed that our native species can do so. As stated in the following chapter, a single ray without any portion of the disk cannot reproduce the missing parts, and there is good reason for believing that a large animal with even one or two rays removed is often destroyed by its enemies before regeneration has taken place. In smaller individuals the injury caused by amputation seems less serious. But it is only when protected by favorable conditions that the injured starfish survives in the struggle for existence.

## REGENERATION

It is said that many years ago, when the starfish first began to be recognized as an important enemy of the oyster, the oyster fishermen sought to wreak vengeance on these devourers by taking such as came into the boat with the oysters, tearing them into two parts and throwing both parts overboard. In how large a proportion of cases such a mutilation resulted in the death of the starfish it is impossible to decide, but an examination of any considerable number of specimens, especially of the common starfish, *Asterias forbesi,* will show how futile are any efforts to destroy the animal merely by tearing it in two, for many individuals will be found in the process of regenerating one or more missing arms.

Such specimens indicate the readiness with which, under favorable circumstances, the starfish may repair its injured tissues, and replace one, two, three, or even four lost or mutilated arms. In fact, when carefully protected and fed in an aquarium, the disk alone, deprived of all five arms, may slowly regenerate all the missing parts.

If an arm be pulled forcibly from the disk, it often happens that a portion of the disk is removed with the base of the arm. If the arm be badly mutilated and not removed, it is usually thrown off by the spasmodic contractions of the muscles at a certain point immediately outside the disk. Very strong chemical or electrical stimuli may cause the same result.

This power of autotomy is doubtless of much importance to the starfish, which can thereby stand a chance of escaping with some of its arms when an enemy has seized one or more. Certain species living in other parts of the world, habitually reproduce themselves by this method of fission, although none of our native species multiply in this manner. In our species the disk alone can restore the arms, but a single arm cannot restore the disk.

Nevertheless it should be emphasized that whenever a starfish is mutilated from any cause it becomes at once more susceptible to the attacks of its enemies, the injured surface furnishing a vulnerable point, from which the protruding soft tissues may be seized by fishes, crustaceans, and other creatures. The whole body may be destroyed before the wounded surface has healed.

An arm removed from the body of a starfish may live for several weeks if protected from the larger carnivorous animals, but will eventually die without regenerating the rest of the body.

But the disk from which one or more arms are missing will, if not destroyed by fishes or other enemies, immediately begin the healing of the wounds and the regeneration of the missing parts.

Careful observations on this point which have been made by Mead* show how rapidly these regenerative processes may occur in the common starfish.

The removal of a single arm has little if any influence on the rate of growth of a young starfish, for such mutilated specimens may grow as rapidly as normal individuals kept under similar conditions. Futhermore the rate of growth of the regenerating arm is on the average somewhat more rapid than that of the remaining arms, so that there is a tendency to restore the normal symmetry of the body. This is shown by the fact that, of five individuals subjected to the experiment, the increase in the length of the largest arm in each during about eight weeks was 8, 10, 10, 11, and 10 mm., while the regenerating arm in the same individuals grew 12, 11, 12, 11, and 9 mm., respectively, in the same period.

The removal of two arms in a young starfish likewise has little if any effect on the rate of growth when food is abundant. In such cases also an accentuated growth in the regenerating arms as compared with the others illustrates again the compensatory properties of the body.

Although, as has been stated, it seems improbable that an isolated arm can, in the common starfish, regenerate the missing parts, yet the result is quite different if a small portion of the disk is removed with the arm. In such cases, although growth ceases for a long time, the normal body may eventually be restored from the small portion of the disk remaining.

Furthermore it is often possible to cut the disk with its attached arms into two or more pieces and from each piece obtain a perfect starfish.

From such results it is conceivable that a starfish taken from the water and torn roughly into two parts may, if a portion of the disk remains attached to each part, eventually form two complete animals by regeneration. That such an event is of usual occurrence, however, is very improbable, because of the enemies which may destroy the injured parts. It is far more likely that the part having the greater portion of the disk will quickly regenerate its missing organs, while the other part will perish.

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* *Bulletin U. S. Fish Commission*, vol. xix, 1899.

The regenerative capacity of the northern starfish, *Asterias vulgaris,* has been the subject of an extensive series of experiments by Dr. Helen D. King.* In this species, as in the common starfish, a single arm without any portion of the disk may live for several weeks, but is unable to reproduce the missing parts of the body.

Of nearly two thousand individuals of this species examined, about eleven per-cent showed one or more arms in process of regeneration. In all cases except one the regeneration involved the production of one or more new arms from the disk, and not a repair of the injured tissues of an arm. It is thus assumed that a badly injured arm is in nature thrown off and replaced by a new one.

When the tip of an arm is removed, however, regeneration of a new tip occurs, and the new eye-spot may be formed within a week after the operation. The regeneration of a complete arm from the disk requires several months.

When the arms are split longitudinally they are always thrown off, except when the tip alone is split. In the latter case two new tips may develop, giving a forked extremity to the arm. Oblique cuts and the removal of small pieces result in the normal regeneration of the injured tissues. The wounds made by cutting the disk may lead to the formation of supernumerary arms, as described in the preceding chapter.

## REPRODUCTION

The starfishes are of separate sexes, although there are no external characters by which the sex is indicated.

One of the chief reasons why the starfish occurs in such enormous numbers, is found in the immense number of eggs produced by a single female. The animals are capable of breeding, as has been recently found by Mead, if the food supply is abundant, when but one year old. As the animal increases in size during succeeding years, an increasing number of eggs or sperm cells are produced annually.

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* *Archiv für Entwickelungsmechanik,* vol. ix, pp. 724-737, 1900.

The sexual glands vary greatly in size according to the degree of maturity of the sexual products. They are voluminous, as shown on Plate V, and occupy, when mature, much of the space within the body walls. The number of eggs produced by a single individual in one year varies with the size of the animal, and is also largely dependent upon the previous food supply.

The genital organs develop in intimate relation with the tissues adjacent to the madreporic canal. When fully formed they consist of five pairs of voluminous feather-like bodies situated in the interradial spaces of the body, and extending freely into the arms, as shown in Plate V. Each gland opens to the exterior by a minute pore on the aboral surface near the base of the corresponding side of an arm.

When the sexual products are fully ripe, the eggs of the female pass out of the genital pores and float about in the water or sink slowly to the bottom.

The males at the same season discharge from similar openings milky clouds containing millions of minute sperm cells. Each of these sperm cells is provided with a vibratile tail, by means of which it swims about in the water. Whenever one of these sperm cells comes in contact with an egg recently discharged from the female, it bores its way into the substance of the egg, and fertilization results. Only a single sperm cell normally enters an egg; if others approach, their entrance into the egg is usually inhibited. If more than one actually succeeds in penetrating the egg substance, abnormal development occurs. Such eggs as are not fertilized within a short time after being deposited perish.

After fertilization a series of internal changes occurs resulting in the fusion of the nuclei of egg and sperm. The processes of cleavage and embryonic development then ensue, as described in the following chapter.

The season at which the sexual products are matured in Long Island Sound varies considerably with different individuals. When examined in the fall the sexual glands of all the small individuals and of many of the larger specimens are small and inconspicuous. During the winter they increase in volume and by early spring have attained nearly full size. Their feather-like processes then extend far out into the cavities of the arms, and they have taken on a rosy color characteristic of approaching maturity. Yet, in spite of the apparent ripeness of the sexual glands, the sperm cells of many individuals lack the activity of full development, and the eggs of the females when examined under the microscope reveal their immaturity.

In May the sexual glands have become so greatly distended in well-fed individuals that the arms appear full and rounded. The feather-like processes of the glands have now become so delicate that a slight injury is sufficient to allow the sexual products, eggs or sperm cells, according to the sex of the individual, to flow out freely into the water. From this time on through the following month the eggs of a majority of specimens can be easily fertilized artificially, and make extremely interesting objects for the study of cleavage and early development. Owing to the minuteness of the sexual products, however, a compound microscope is necessary for the study.

To obtain the eggs for study plenty of clean sea water must be at hand together with suitable receptacles of glass or porcelain. Soup dishes or common tumblers are very convenient, but must be kept covered. The starfishes must, of course, be kept alive in sea water, and in order to insure ripe products of both sexes a considerable number of specimens should be available.

After placing clean sea water in one of the vessels a starfish may be taken and, by means of strong scissors, opened by removing the aboral surface of one or more of the arms. The feather-like glands may be taken with a pair of forceps and shaken gently in the vessel of water. A milky cloud issuing from the cut end of the gland indicates that the specimen is a male, the cloud itself being made up of thousands or millions of sperm cells. If, on the other hand, instead of a milky cloud, there issues a stream of tiny particles barely visible to the naked eye, the animal opened is a female, and the little particles are the eggs, or ova. Examination of a drop of the contents of the vessel under a microscope will prove definitively which sex has been obtained. One or more other starfishes must be opened in a similar manner, the generative products of each being received in a separate vessel, until the genital products of both sexes have been obtained.

After the eggs in one of the vessels have settled to the bottom, the greater part of the water should be poured off and be replaced by clean water. No more eggs should be left in the vessel than will cover the bottom in a single layer. A drop or two of the water in a vessel containing the sperm should now be added to the eggs, and will probably contain a sufficient number of sperm cells to fertilize all the eggs present.

Within an hour and a half after fertilization, the eggs, which should be examined from time to time under the microscope, will have divided into two cells. The four-, eight-, twelve-, and sixteen-celled stages follow rapidly, and resemble the cleavage stages of the sea-urchin shown in Fig. 15.

In about twelve hours more, if the temperature is fairly warm, free-swimming ciliated embryos will be found. If a few embryos are kept in plenty of clean, cool sea water, they will live for several days and develop into the so-called brachiolaria stage, as shown in Fig. 4.

Under the normal conditions of the sea, the free-swimming stages last about three or four weeks, after which such larvæ as have survived settle to the bottom and attach themselves to rocks, seaweeds, eelgrass, or other objects, and by a complicated metamorphosis become transformed into tiny starfishes.

As has been stated above, the majority of individuals of the common starfish mature their genital products in May and June, and discharge them into the water during the latter month. There is, however, great individual variation in this respect, for an examination of a large number of specimens at any season of the year, even in the fall, will show some in which the genital glands are large and contain ripe or nearly ripe sexual products. Furthermore, during the months immediately following the normal spawning season there are some individuals which are filled with mature genital glands. Such individuals apparently represent instances of belated maturity of the sex products, or those which for some reason have failed to discharge their ripened germ cells at the normal time.

Such individuals, however, probably have little influence in propagating the species; for, even if their sexual products are discharged into the water, there is very little chance that fertilization can occur at other times than in the normal spawning season, when the water is swarming with the germ cells of both sexes.

Because of the vastness of the volume of the surrounding sea water it is only when both sexes discharge their products within reasonable proximity to each other and at very nearly the same time that the eggs have any chance of being met by the sperm cells. Nevertheless, under favorable conditions of currents in the water, the sperm cells may be carried to eggs deposited at some considerable distance, probably several hundred feet.

Except in rare instances, therefore, such individuals as fail to mature their sexual cells at the normal period and discharge them into the water in the vicinity of one or more individuals of the opposite sex give rise to no offspring during that season. Moreover, it is uncertain as to whether such sexual products as mature at unusual seasons are discharged from the body.

The northern starfish, *Asterias vulgaris,* exhibits breeding habits similar to those described for the common starfish. In this species also the sexual products mature in summer.

The breeding habits of the blood starfish (*Henricia*) differ widely from those of the two preceding species of *Asterias,* in that there is no free-swimming larval stage. The eggs of this species are large and heavy, being filled with an orange-colored yolk. But few eggs are produced by each female. They give rise to embryos which pass though an abbreviated larval development, and quickly assume the form of the adult. Fisher has recently described* the brooding of the eggs in the case of one of the Pacific coast varieties of this species. The brood pouch is formed by arching the disk and bringing the bases of the rays close together. Into this cavity the eggs are tightly packed, and the developing young are thus protected by the mother until after the adult form has been reached.

The slender-armed starfish (*Asterias tenera*) is stated to brood its eggs and developing young in the same manner.

## DEVELOPMENT

**Common Starfish.** — The eggs of the common starfish, as stated in the preceding chapter, are set free in the surrounding sea water mainly during the month of June. The developmental processes are very complicated, and many of the details are not yet well understood. A general account of the larval stages is given in the earlier papers by Agassiz,* and by Mead.†

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* *U. S. National Museum, Bull.* 76, p. 277, 1911.

The eggs fall to the bottom, and after fertilization the process of cleavage takes place, as described for the egg of the sea-urchin (page 100). In about twelve hours the substance of the egg has been subdivided into hundreds of cells which arrange themselves to form the body of an embryo. The surface of the body becomes covered with hair-like processes, termed cilia, which are kept in constant vibration and enable the embryo to leave the bottom and swim free in the water.

The body of the embryo becomes further differentiated, and a mouth, digestive system, and other organs are formed. The embryo can now take into its body still smaller organisms than itself for food, and under favorable conditions increases rapidly in size. Meanwhile the rounded shape of the body has changed into a structure with a number of projecting lobes covered with very long cilia, and the embryo is now termed a *bipinnaria*. In this stage the embryos are very sensitive to light and atmospheric conditions, and collect in vast swarms which at times float near the surface and at other times sink deeper into the water. They may be carried back and forth by the tides, winds, and currents, and become widely separated from their birthplace. They have a considerable power of locomotion, but do not swim for a long time in any given direction.

By further modifications the embryo develops into the strange-looking, transparent creature shown in Figs. 4 and 5. In this stage, known as the *brachiolaria,* the body is provided with several pairs of long arms covered with vibratile cilia. As the brachiolaria bears no resemblance whatever to the adult starfish, naturalists for a long time supposed it to be an entirely different kind of animal. And yet from such a creature the young starfish develops by a complicated metamorphosis.

After swimming about in the water for some three or four weeks, depending largely upon temperature and other external conditions, the larva becomes full-grown, and the brachiolaria is now some fifty times as large as the original embryo. It is now ready for the metamorphosis.

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* On the Embryology of Echinoderms. *Proceedings Am. Acad.*, 1863; and *Mem. Am. Acad.*, 1864. North American Starfishes. *Mem. Museum of Comparative Zoölogy*, 1877.

† The Natural History of the Starfish. *Bull. U. S. Fish Commission* for 1899.

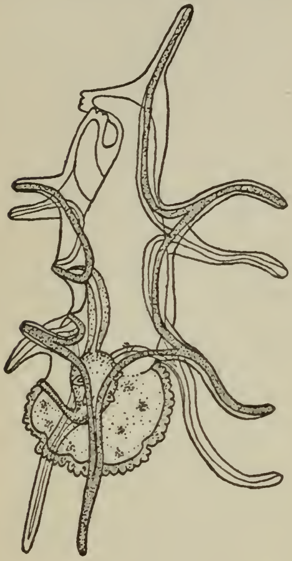

FIG. 4. Free-swimming larva (Brachiolaria) of starfish. (After Weysse.)

The wavy disk-like area at the lower end of figure represents the portion of the body which will remain after the transformation to the adult stage. Compare Figs. 5 and 6.

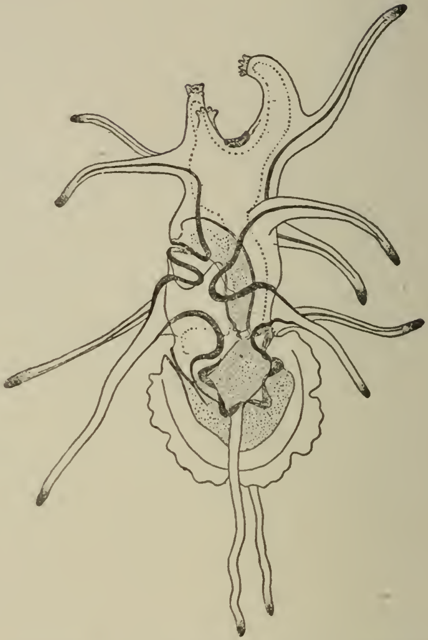

FIG. 5. Free-swimming larva (Brachiolaria) of starfish. (After Mead.)

The stippled areas in the central and lower parts of the figure indicate the position of the digestive tract, the mouth being shown at the left-hand edge of the figure, with the intestinal opening below.

The external changes by which the metamorphosis is accomplished, and the habits of the young starfish, are described by Mead* as follows:

"Already the rudiment of the resulting starfish can be seen within the brachiolarian. The five crenate lobes on the margin of the disk are the beginning of the five arms. The disk itself at this time is already somewhat opaque.

"When the larva is about to 'set,' it attaches itself to some object, like a spear of eelgrass, by the suckers, shown at the top of the figure (Figs. 4 and 5), and then a rapid transformation occurs. The whole superstructure above the disk collapses and becomes absorbed like the tail of a tadpole. In a few hours the brachiolarian has disappeared, and a starfish proper (Fig. 6) has taken its place.

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* *Bull. U. S. Fish Commission* for 1899.

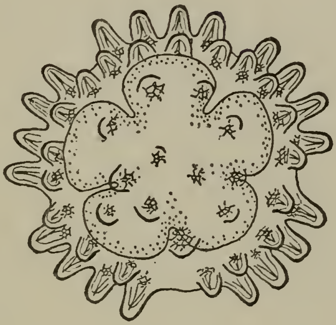

FIG. 6. Aboral surface of starfish shortly after the metamorphosis. (After Brooks.)

"Up to the very time when the larvæ are ready to set they swim freely in the water; and larvæ, caught in the tow-net, often set in the dish of water before I had returned to the house-boat, *i. e.*, within an hour of the time they were caught. In this condition they attach themselves by their suckers to any object they happen to strike, and cling to it with great tenacity until the metamorphosis is completed. As the larvæ are borne along by the currents, the eelgrass, rockweed, and especially the fluffy, branching seaweed, naturally catch immense numbers of them. I think it would not be an exaggeration to say that on a single handful of seaweed which I picked up about the first of July there were more than a thousand young stars. For the next three weeks they remain for the most part crawling about over this vegetation, gradually working down among the roots of the rockweed and upon the large stones at the bottom. They grow rapidly during this time, but decrease in numbers, for they are bright and conspicuous objects for the small fishes; yet they are exceedingly numerous for a long time. In order to obtain a definite expression of their abundance, I scooped up a large handful of the fluffy seaweed, which, together with the water, filled about two-thirds of a paper pail, and from this 603 young stars were taken. A cart-load of seaweed taken out at this time would have destroyed millions of starfish.

"By the first of August the fluffy, branching seaweed, which bore so many young stars, was nearly all dead, and though the stars were still present in great numbers upon the eelgrass, rockweed, and stones covered with sea-moss, they were also frequently seen crawling along the muddy bottom. By August 15 the eelgrass was overgrown and lodged by a luxuriant growth of *Botryllus,* a compound ascidian, which appears as dark gelatinous patches. The small stars were still numerous upon it, but were rather thin and poor. The larger and better nourished stars had left the eelgrass and were searching for food upon the stones and along the bottom.

" The small starfishes, such as live upon the eelgrass, are remarkably hardy in some respects. They will live for weeks, and even months, in a small dish, without change of water and with a minimum amount of food. During the first week in July I carried a number of free-swimming brachiolaria to Providence for further examination. They were in a glass 1-quart jar, and, after one or two were taken out, the jar was closed and was left unopened during the rest of the summer. In a few days the larvæ had all set, and when I examined the dish again, on September 5, it contained still a few live stars, which were, however, very small. Upon watching them it was seen that the more enterprising individuals were eating their companions, and finally only one remained. This one lived in the jar for weeks, but, unfortunately, I am not able to record the exact date of his death.

" On the other hand, the same young starfishes, which can live so long without food or change of water, perish quickly if left out of the water, especially if the sun is shining. They cannot live, therefore, above the low-water mark, unless sheltered by a dense growth of vegetation. Large stars can endure very much longer exposure, since their bulk prevents their drying so quickly. On July 16 I made a special search for young stars on the seaweed, above the low-water mark. I found none, yet just below low-water mark they were excessively abundant. At the same time it was noticed that above the line where the starfish were abundant there was a thick set of 1-year-old oysters, while below it the oysters were absent. The oysters set somewhat later in the season than the starfish, and the latter, therefore, are ready to prey upon the young oysters as soon as they appear. When, in addition to these facts, we take into account the extraordinary voracity of the young starfish, their immense numbers, and their special fondness for oysters, we are led to conclude that one reason why a considerable set of oysters is so rarely obtained below low water is that they fall prey to the starfish. The oysters which set above low water are comparatively safe, for when the tide leaves them uncovered they can endure for hours the direct heat of the sun, which would kill the young starfish in a few minutes.

"While the starfish are living upon the eelgrass and seaweed they are supplied with an abundance of food in the form of the young of marine worms, snails, and other animals, which, like the stars themselves, swim freely in the sea for a time, and then settle down upon any object with which they happen to come in contact. Throughout July the water at Kickemuit was teeming with minute free-swimming creatures, and in the aquarium the growth of the youngest stars could be greatly accelerated by feeding them the contents of the tow-net. During the last four days of June innumerable larvæ of a marine worm (*Syllis*) were swarming at the surface, and on July 11 millions of the young of one of the sea snails (*Littorina?*) were caught in the tow-nets.

"The clam, also, is one of those unfortunate animals whose larvæ set at about the same time as the starfish, and in the same places. The starfish before they are three days old show a predilection for young clams, which apparently does not diminish so long as any clams remain."

In Fig. 7 one of these young starfish is shown in the act of devouring a small clam. A single young starfish has been known to devour as many as 56 small clams within a period of six days.

"From the foregoing it appears that the starfish set for the most part during the last few days in June and the first week in July, some as late as July 16. They remain upon the seaweed in immense numbers until about the 1st of August, when many of them are found upon the bottom. By August 15 the greater portion of the stars have left the seaweed and gone to the bottom.

"The stars could be destroyed by hundreds of thousands in July by collecting and drying a few cartloads of seaweed taken below low-water mark. After the first week or two of July the collection of seaweed would do no injury to the clams."

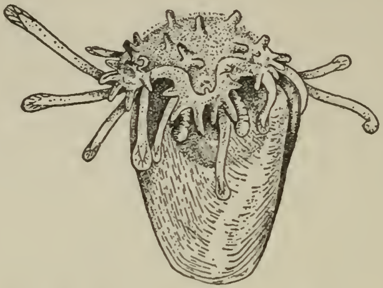

FIG. 7. Very young starfish in the act of devouring a mollusk. (After Mead.)

The rate of growth of the young starfish is discussed on page 40.

**Northern Starfish.** — The larval stages of the northern starfish have been studied by Agassiz*, Field†, and others, while Goto‡ has made detailed investigations on the metamorphosis. According to these observations the development of this species is similar to that described for the common starfish.

**Slender-armed Starfish.** — This species is reported as producing a small number of comparatively large eggs, which develop without free-swimming stages. It is also said to protect its eggs and embryos beneath the peristome until the young starfishes have reached a diameter of several millimeters.

**Blood Starfish.** — In this species only a few large eggs are produced. These develop into the adult form by a complicated metamorphosis, although, as stated on page 52, the larvæ do not swim free in the water.

## KEY TO SPECIES

The starfishes of the world may be divided into five orders, only two of which are found in Connecticut waters or in their vicinity. The order **Spinulosa**, represented by the beautiful little blood starfish, *Henricia sanguinolenta,* includes the more primitive forms, in which the disk and rays are everywhere thickly covered with minute spines, but there are no pedicellariæ. In this order there are but two rows of tube-feet. The order **Forcipulata** includes our three species of *Asterias.* In this order the disk and rays have scattered coarse spines, and very numerous pedicellariæ. There are usually four rows of tube-feet.

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* *Mem. Museum Comparative Zoölogy,* 1877.

† *Quarterly Journ. of Microscopical Science,* 1892.

‡ *Journ. College of Science, Imp. Univ. Tokio,* 1898.

Our native species may be distinguished by the following characters:

1. Disk and rays comparatively smooth, covered with minute, closely set spines; pedicellariæ absent; tube-feet in two rows ........................ **Henricia sanguinolenta**

   Disk and rays rough, with coarse spines; forceps-like pedicellariæ abundant; tube-feet in four rows............2

2. Rays nearly cylindrical, tapering and slender; spines very numerous, slender, sharply pointed, usually surrounded with a broad wreath of small pedicellariæ............... **Asterias tenera**

   Rays broad, somewhat flattened; spines thick and blunt....3

3. Rays blunt at the ends; skeleton quite firm; spines scattered; pedicellariæ near ambulacral grooves short and broad; madreporic plate usually orange........**Asterias forbesi**

   Rays pointed at the ends; skeleton rather soft; spines scattered, but often forming a rather distinct median longitudinal row on the aboral side of each ray; pedicellariæ near ambulacral grooves slender; madreporic plate pale yellow ............................**Asterias vulgaris**

### **Asterias forbesi** (Desor)

Common Starfish

Plate I, fig. 4; Plates II, III, IV, VI, VII, VIII.

This well-known pest of the oyster is found along the Atlantic coast from the Gulf of Mexico to Maine, and is the only species of starfish which is common in the greater portion of Long Island Sound.

The species is so generally distributed in the Sound that the mention of specific localities would be superfluous. As a rule it is most abundant on shelly bottoms in shallow water. In the fall the tide pools in rocky localities along the shore are often crowded with young starfishes measuring from a half-inch to three inches between tips of opposite arms. These are feeding on the barnacles and young oysters which are attached to the rocks. At the approach of winter most of the starfish leave the shore and migrate into deeper water.

In spite of the thousands of bushels of these starfishes which are annually destroyed by the oyster growers there seems to be no diminution in their numbers except in restricted localities.

The size of average mature individuals of this species is from four to six inches between the tips of the opposite arms, but much larger individuals are sometimes found. The variation in the number of rays is discussed on page 43. The shape of the rays depends somewhat on the state of contraction of the ambulacral groove, and varies with the state of development of the sexual glands and the general nutrition of the body. In general (as shown on Plates II, III, IV, and VIII) they are thick and stout, with blunt and rounded tips.

Individuals of this species can usually be distinguished from those of *Asterias vulgaris* by the difference in the proportions of the rays, as shown on Plate VIII. The latter species usually has more slender and pointed rays, while those of the common starfish are comparatively thick and blunt.

The coloration of this species is subject to great variation, the most common shades being greenish or brownish green, with light yellow spines and orange-red madreporic plate. The colors of other specimens range through brown, bronze, orange, and purple. There seems to be little if any correlation between the color of the animal and the age, sex, or environment, although in

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Explanation of Plate VIII. Upper figure, *Asterias forbesi.* Three-fourths natural size. Lower figure, *Asterias vulgaris.* One-half natural size.

Photographs of dried skeletons from oral surface, to show the different proportions of the arms in the two species. The skin, tube-feet and other soft parts have been removed. Around the mouth may be seen in each figure five groups of large spines, the oral spines, or mouth papillæ. In the upper specimen the oral spines lie in the positions they occupy when the mouth is closed, while in the other specimen the mouth is fully opened. The ambulacral grooves are widely opened, and show the four rows of openings for the tube-feet in each groove. (From photographs loaned by Prof. A. E. Verrill.)

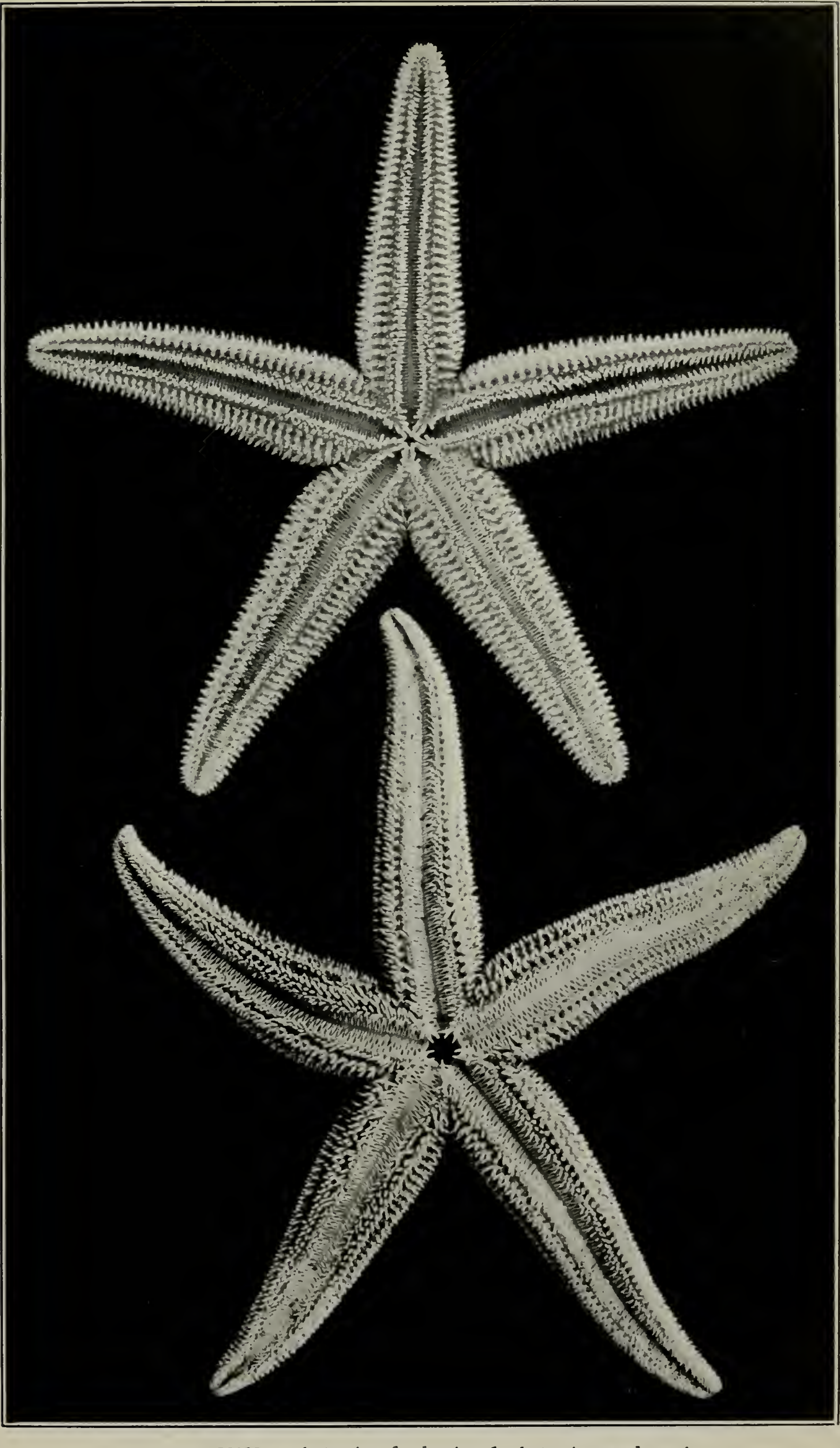

PLATE VIII. *Asterias forbesi* and *Asterias vulgaris.*

restricted localities a definite color variety may predominate. After death the body assumes a dull reddish or orange color, and the madreporic plate is yellow or brown.

The plates of the aboral surface bear numerous blunt spines surrounded by circles of pedicellariæ (Plate III). The respiratory papulæ, or branchiæ, are grouped in clusters of four to six or more in large areas between the spines. Each of the plates adjacent to the ambulacral grooves bears usually two slender, flattened, sharply truncated spines. The number of such plates increases with the growth of the animal, being from 80 to 120 in well grown individuals.

A full and interesting account of the habits and life history of this species is given by Mead, in the Bulletin of the U. S. Fish Commission for 1899.

### **Asterias vulgaris** Verrill

Northern Starfish

Plates V, VIII, IX.

Although this species is found in the colder waters of the eastern part of the Sound, its more usual habitat is farther to the northward. It is occasionally found as far west as Faulkner's Island and the Thimble Islands, but becomes more common from New London eastward, particularly in the deeper and colder waters.

This is the common starfish north of Cape Cod, and ranges northward to the coast of Labrador. In the deeper, colder waters off the Atlantic coast the species extends south as far as Cape Hatteras. In certain localities, as at Woods Hole, Mass., Narragansett Bay, and the eastern part of Long Island Sound, this species is sometimes associated with the common starfish. The same or a very similar species occurs on the coast of Europe, where it is known as *Asterias rubens*.

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Explanation of Plate IX. *Asterias vulgaris*. About one-half natural size.

Photographs of living individuals, from aboral and oral surfaces. In the upper figure the disk is somewhat unusually swollen. The lower figure shows the four rows of tube-feet and the mouth. These figures well illustrate the characteristic arrangement of the spines on both surfaces of the body.

(Photographs loaned by the U. S. Fish Commission, with permission of Dr. H. L. Clark.)

In general it is possible to distinguish our two species by the shape of the body, the arms being thicker at the base and more pointed at the tips in the northern starfish (Plates VIII, IX), while those of the common starfish are rounded and blunt at the tip. The spines along the middle of the aboral surface of each arm often form a conspicuous median row (Plate IX) extending the length of the arm, while those of the common starfish are scattered more irregularly.

Another specific distinction may be found in the shape of the major pedicellariæ, particularly those on the adambulacral spines, as shown in Fig. 8. Instead of the broad, rounded pedicellariæ found in *A. forbesi,* many of those of the present species have long and pointed blades.

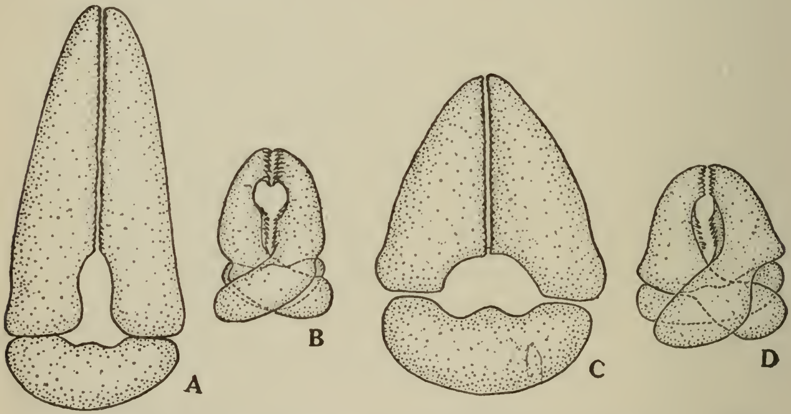

Fig. 8. Calcareous plates of pedicellariæ of *Asterias.* A, major pedicellaria, *Asterias vulgaris;* B, minor pedicellaria, *A. tenera;* C, major pedicellaria, *A. forbesi;* D, minor pedicellaria, *A. forbesi.* All from adambulacral spines. Enlarged 90 diameters.

This species grows to a much larger size than does the common starfish, full-grown individuals often measuring eight inches or more between the tips of opposite arms. Specimens more than 16 inches in diameter have been recorded from Nova Scotia.

The coloration shows great variation, yellow, yellowish brown, orange, and purplish specimens being most abundant, although shades of pink and red are sometimes present. The madreporic plate is usually pale yellow. The spines are generally of lighter color than the surface of the body.

## **Asterias tenera** Stimpson

### Slender-armed Starfish

### Plate X.

In the paper by Stimpson* in which the original description of *Asterias tenera* occurs, there is described another, very similar species, under the name of *A. compta,* based on a single specimen three inches in diameter.

*Asterias compta* was thought to differ from *A. tenera* in being of somewhat less slender proportions, in having the rays more depressed, and particularly in having the spines, especially towards the tip of the rays, surrounded by broad wreaths of pedicellariæ. The type locality for *A. tenera* was Massachusetts Bay, and for *A. compta* off the coast of New Jersey.

From an examination of the records of the collections of this species by the United States Fish Commission, Verrill† gives the distribution of *A. tenera* as Cape Cod to Newfoundland in 10 to 129 fathoms, and states that the species is abundant in Massachusetts Bay and the Bay of Fundy in 10 to 40 fathoms.

Verrill states that *A. compta* is large and abundant in the cold area south of Rhode Island and Marthas Vineyard in 20 to 50 fathoms. He emphasizes the close relationship of the two so-called species, and suggests that *A. tenera* may be only a poorly nourished, slender variety of *A. compta.* Clark‡ has examined both varieties and considers them specifically identical.

An examination of a large number of specimens of both forms belonging to the Yale University Museum has failed to show any definite anatomical characters by which they can be invariably distinguished. Many of the specimens can be placed without hesitation in the one group or the other, but others, and

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* *Proc. Boston Soc. Nat. Hist.,* pp. 269, 270, 1862.

† Distribution of the Echinoderms of Northeastern America. *Am. Journn. Science,* vol. xlix, 1895.

‡ *Bull. U. S. Fish Commission,* 1902.

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EXPLANATION OF PLATE X. *Asterias tenera.*

Fig. 1. Oral surface of dried specimen showing the slender spines surrounded by dense wreaths of pedicellariæ; about twice natural size.
Fig. 2. Aboral surface; natural size.
Fig. 3. Oral surface of a small specimen preserved in alcohol, showing the broad ambulacral grooves with tube-feet; natural size.
Fig. 4. Oral surface of dried specimen; natural size.

particularly the smaller specimens, possess such intermediate characters that it has been found impossible to place them in either group. Therefore but a single species can be recognized at present, and, as the description of *A. tenera* precedes that of *A. compta* by a single page, the former has priority.

On the coast of Europe occurs a very similar species, *A. Mülleri*, and it is not certain that this is specifically distinct from our *A. tenera*. Further examination of a large series of both forms is needed to determine the matter with certainty.

*Asterias tenera*, including both varieties, as shown by the records of the U. S. Fish Commission, ranges from off the mouth of Chesapeake Bay northward to Nova Scotia, in from 10 to 129 fathoms. It is recorded from the eastern end of Long Island Sound, off Watch Hill, Rhode Island, but is more abundant in the colder water farther off the coast and to the northward.

The individuals of this species are small in size. Mature specimens commonly measure only from two and one-half to four inches between the tips of opposite arms. A few larger specimens have been obtained, but the vast majority of specimens in the extensive series belonging to the Yale University Museum are less than three inches in diameter.

The species may be distinguished from our other species of the genus by the nearly cylindrical, slender, pointed arms (Plate X). The disk is small, the slender arms being from five and one-half to seven times as long as the diameter of disk.

The color in life is pale, sometimes nearly white; often pale purplish or pinkish. The madreporic plate and the spines are whitish.

The rather open meshwork of plates on the aboral surface carries very prominent, slender spines (Plate X, fig. 2) which do not form a clearly defined median row on the arms, as they do in *Asterias vulgaris*. In the majority of specimens all the spines except those on the disk are surrounded by a conspicuous wreath of pedicellariæ (Plate X, figs. 1 and 4). They are more closely crowded toward the tip of the ray. In some individuals pedicellariæ occur upon the spines of the disk, while in others they are almost entirely limited to the rays. Usually one, two, or a few much larger pedicellariæ are found on the oral surface of the disk in each of the angles between the rays.

When the spines of the disk are free from pedicellariæ, groups of such organs appear at the beginning of the rays near the bases of the spines, and these groups develop into conspicuous wreaths on the more prominent spines of the rays. The wreaths are most conspicuous on the large spines about the ambulacral grooves and toward the tip of the rays (Plate X, fig. 1).

The individual pedicellariæ in these wreaths, while relatively large as compared with the size of the spine, are much smaller than in our two other species of the genus (Fig. 8). They are usually oval in outline, with rather blunt points.

The madreporic plate is small, and provided with a few very wide furrows.

The branchiæ are usually separate or in groups of two in each branchial area.

As is the case with several other species of the genus, this little starfish protects its eggs and young beneath the disk, and carries about with it the young clinging to the partially everted borders of the mouth.

### **Henricia sanguinolenta** (O. F. Müller)

Blood Starfish

Plate I, figs. 1—3; Plate XI.

This beautiful little starfish is known in the writings of most American zoölogists by the name of *Cribrella sanguinolenta*. It has recently been shown, however, that the generic name *Henricia* must take precedence over the more familiar *Cribrella*.

Like the preceding species, this is more properly a northern form, and grows far more abundantly and of larger size along the coasts of Maine and Labrador than farther south. It occurs, however, in the cold, deep water off our coast as far south as Cape Hatteras, and has been taken at a depth of more than a thousand fathoms.

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Explanation of Plate XI. *Henricia sanguinolenta.*

Fig. 1. Aboral surface of disk, showing madreporic plate, intestinal opening, and arrangement of spines; three times natural size.
Figs. 2 and 3. Aboral and oral surfaces; about two-thirds natural size.
Fig. 4. Oral surface of dried specimen; slightly enlarged.

To the northward it extends not only along the Atlantic coast of North America but also to Greenland, and is found also on the northern coasts of Europe and Asia. It occurs from the Azores to the British Islands, Scandinavia, and Spitzbergen, and along the shores of the Arctic Ocean to Bering Strait. On the American side of the Pacific Ocean the species extends as far south as Washington, and on the Asiatic side southward to the Kurile Islands. This would indicate a typical circumpolar species which extends southward along the continental shores to latitude 38° to 48° N.

In Long Island Sound the blood starfish appears to be limited to the eastern part, which has deeper and colder water than is found elsewhere. It extends at least as far west as New London.

It is at once distinguished from our species of *Asterias* by having only two rows of tube-feet beneath each arm, arranged in a single row along each side of the narrow ambulacral groove (Plate XI). The proportions of the body vary greatly, as shown on Plate I. The arms are either rounded or flattened at the base, but are always rounded or nearly cylindrical distally, and are comparatively slender and acutely pointed (Plate I). In some specimens (Plate XI) the arms are swollen near the base, and sharply contracted between base and disk. Sometimes the tips of the arms are slightly raised and curved aborally, and the two arms of the bivium are brought closer together than are any of the others (Plate XI).

The aboral surface lacks the prominent spines of *Asterias,* the whole surface being comparatively smooth, but actually covered everywhere with minute closely set spines (Plates I and XI).

The branchiæ are usually scattered singly in minute spaces between the thickly placed spines. The madreporic plate is small, and marked by a few broad grooves. The anal opening is more conspicuous than in *Asterias* (Plate XI, fig. 1).

Specimens from Long Island Sound rarely exceed three or four inches between the tips of opposite arms.

The colors are unusually deep and bright, rendering the animal very conspicuous when exposed to full view. The usual color is bright red or orange on the aboral surface, although cream-colored, yellow, pink, lavender, and purple specimens are sometimes found. Occasionally the surface is mottled red and purple. It has been said that a glass dish filled with these starfishes might vie with a tulip bed in gaiety and vividness of tints. The oral surface is deep yellow.

The few large eggs laid by each female in early spring develop by a complicated metamorphosis, but the adult condition is reached without passing through a free-swimming stage. In this species the eggs and young are protected beneath the disk of the mother.

## Class 2. OPHIUROIDEA

The representatives of this class are known popularly as serpent stars, snake stars, brittle stars or sand stars. The species which occur in the waters of Long Island Sound are small and inconspicuous as compared with the common starfish or the sea-urchin, and are seldom noticed by the ordinary visitor to the seashore. They are protectively colored, so that it is very easy to overlook them when their slender arms are stretched out among the roots of the eelgrass or coiled up in crevices of rocks. Furthermore they are of a retiring disposition and largely nocturnal in their habits, remaining secluded as much as possible during the daytime. Some forms live beneath stones or hidden among seaweeds in small crevices of the rocks. One species, *Amphioplus abditus,* lives buried in the mud, with one or more arms projecting above the surface. It is only when they are disturbed and are moving their delicate arms in an effort to escape that they are at all likely to attract the attention even of a trained observer. And, finally, although they occur in great abundance in certain localities, in most places they are so scarce or so well protected by their habits and coloration that careful search for hours at a favorable tide will fail to disclose a single specimen.

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Explanation of Plate XII. Variation, *Ophiopholis aculeata.*

Photographs of five individuals to show some of the variations in form, length of arms, and color patterns of this extremely variable species. These figures represent but a few of the innumerable positions which the arms can assume in the living animal. In the upper left-hand figure all the arms are in process of regeneration. (All figures three-fourths natural size.)

## STRUCTURE

The class Ophiuroidea contains hundreds of species distributed all over the world. Four of these species are known to occur in Long Island Sound, and one other has been found so near the eastern entrance to the Sound that it seems probable that further investigation will reveal its presence in Connecticut waters.

They all have a flattened, circular or pentagonal body, called the disk, with five very slender, flexible, jointed arms, or rays (Plate XII). These arms taper gradually toward the tip, and their movements in life are such as to warrant the popular appellation, "serpent stars," for, when the animal is disturbed, each one twists in all directions and folds itself about adjacent objects in a truly serpentine fashion.

The mouth is placed in the center of the disk, in a position similar to that in the starfish. Hence the side of the disk containing the mouth and the corresponding faces of the arms make up the oral surface, while the opposite side of the disk and arms is the aboral surface. The mouth is provided with five triangular jaws, each situated between a pair of arms, that is, in one of the interradial spaces (Plate XIII).

The arms are distinctly marked off from the disk, and do not pass gradually into it like those of the starfish. Ambulacral grooves are wanting, and the tube-feet are very delicate.

The disk contains all the digestive and reproductive organs, the arms containing only a row of calcareous ambulacral ossicles

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EXPLANATION OF PLATE XIII. Skeleton of Ophiuran. *Ophiopholis aculeata.* (Four times natural size.)

Photographs of disk and bases of rays from oral and aboral surfaces to show characteristic arrangement of plates. The upper figure shows the granulations and very blunt spines which cover many of the plates of the disk, leaving only about forty of the plates exposed. In many specimens the number of exposed plates is smaller; sometimes as few as six are thus left bare. These exposed plates are usually grouped symmetrically in the five radial and five interradial areas, with a single plate in the center of the disk. The upper arm plates are seen to be separated by a row of plate-like granules.

The lower figure shows the five jaws, with four scale-like projections, oral papillæ, on each side of each jaw. In the interradial areas are five large plates, oral shields. It will be noticed that the oral shield between the arms nearest the top of the page is larger than any of the other four, and forms the madreporic plate. On each side of the ventral arm plates is a single row of flattened spines, the tentacle scales.

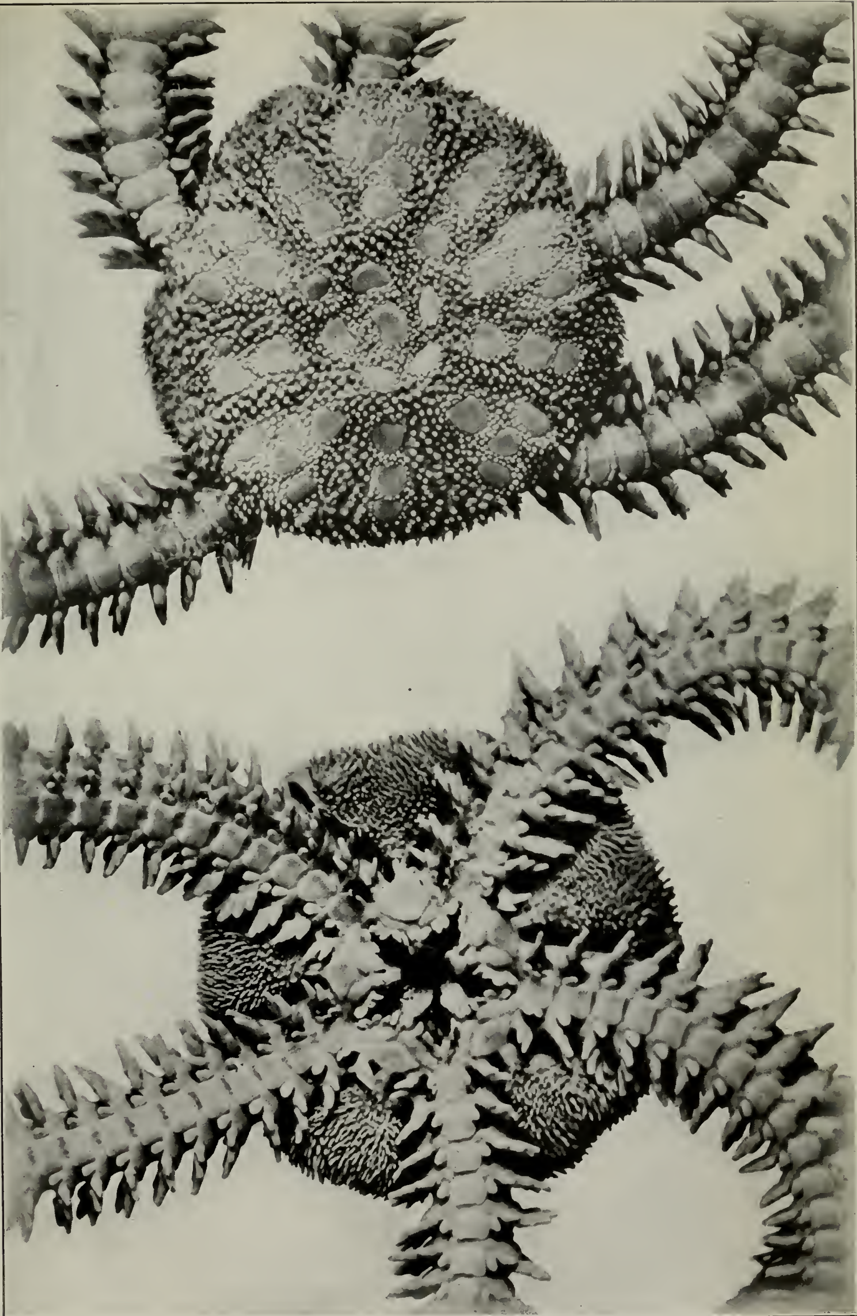

PLATE XIII. Skeleton of Ophiuran, *Ophiopholis aculeata*. (Four times natural size.)

with a slender branch of the body cavity, together with small nerves and branches of the water-vascular system.

The mouth leads into a narrow esophagus, and this opens into a large saccular stomach, which fills up most of the space within the disk. There is no anal opening, the indigestible remains of the food being cast out of the mouth.

**Disk.**— The disk is covered with thin plates on all sides. Certain of these plates present such definiteness in form and arrangement that they afford the most convenient characters for distinguishing the various species.

On the oral surface five triangular groups of plates project in toward the center of the disk and form the jaws (Plate XIII). The jaws are usually provided with numerous toothlike processes or flattened scales constituting the masticatory apparatus. These processes are known as oral papillæ, tooth papillæ, and teeth, according to the position they occupy on the jaw. The oral papillæ are toothlike projections along the edges of the jaws, while the tooth papillæ, when present, are similar structures at the point of the jaw, and the teeth are five series of plates which project from the mouth opening toward the interior of the body. The oral papillæ and teeth are well shown on Plate XIII, while Fig. 9 represents in a diagrammatic way the relations of the same plates. The number and arrangement of these processes are characteristic of each of the different species.

The jaws are provided with a musculature which permits them to be opened widely (Plate XIII and Fig. 9) or closed tightly. In the specimen shown on Plate XIV two adjacent jaws are thus closed, while the remaining angles of the mouth have remained open. In most species the jaws, teeth, and oral papillæ are not so much used in crushing the food as in separating out and swallowing the smaller or softer particles.

A large plate at the base of each jaw is termed the oral shield, while the pair of smaller plates on the face of the jaw, and beside or internal to the oral shield, are the adoral plates (Plate XIII and Fig. 9).

On the aboral surface there is great variation in the number and size of the plates, but one pair — the radial shields — lie at the base of each arm. In some species, as *Amphipholis squamata,* these radial shields are very large and conspicuous (Plate XVII), while in other species they are more or less completely covered by the more superficial scales of the disk (Plates XIII and XIV).

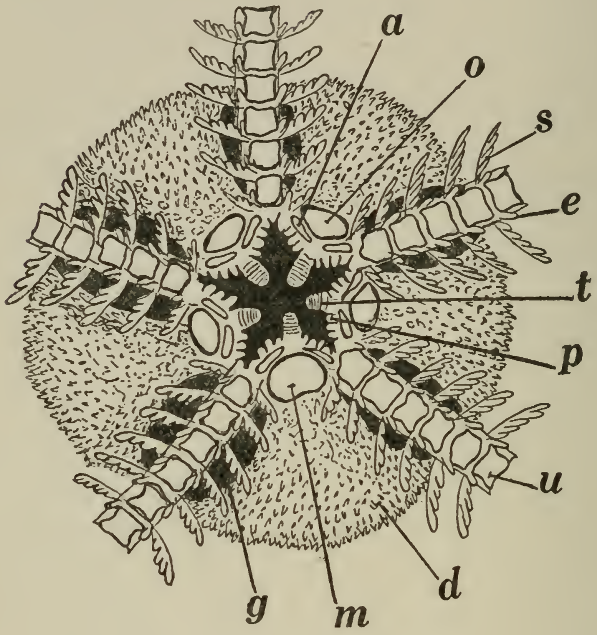

FIG. 9. Oral surface of disk and bases of arms of *Ophiopholis aculeata; a,* adoral plate; *d,* disk, with small, blunt spines covering the plates; *e,* tentacle scale; *g,* genital slit; *m,* madreporic plate (modified oral shield); *o,* oral shield; *p,* oral papillæ; *s,* arm spine; *t,* tooth; *u,* under arm plate.

**Arm plates.**— The arms are covered on all sides by a complicated system of thin plates and spines. The form, number, and arrangement of these parts are used in the classification of the group, so that one must examine them closely in order to determine the name of any one of our native species. A single row of plates, the upper arm plates, usually lies along the aboral surface of each arm; and a similar row, the under arm plates, often with plates of different size, occupies a similar position on the oral surface (Fig. 9). Beside these upper and under arm plates, and occupying more or less of the lateral surfaces of the arm, often occur one or more series of smaller plates, and these

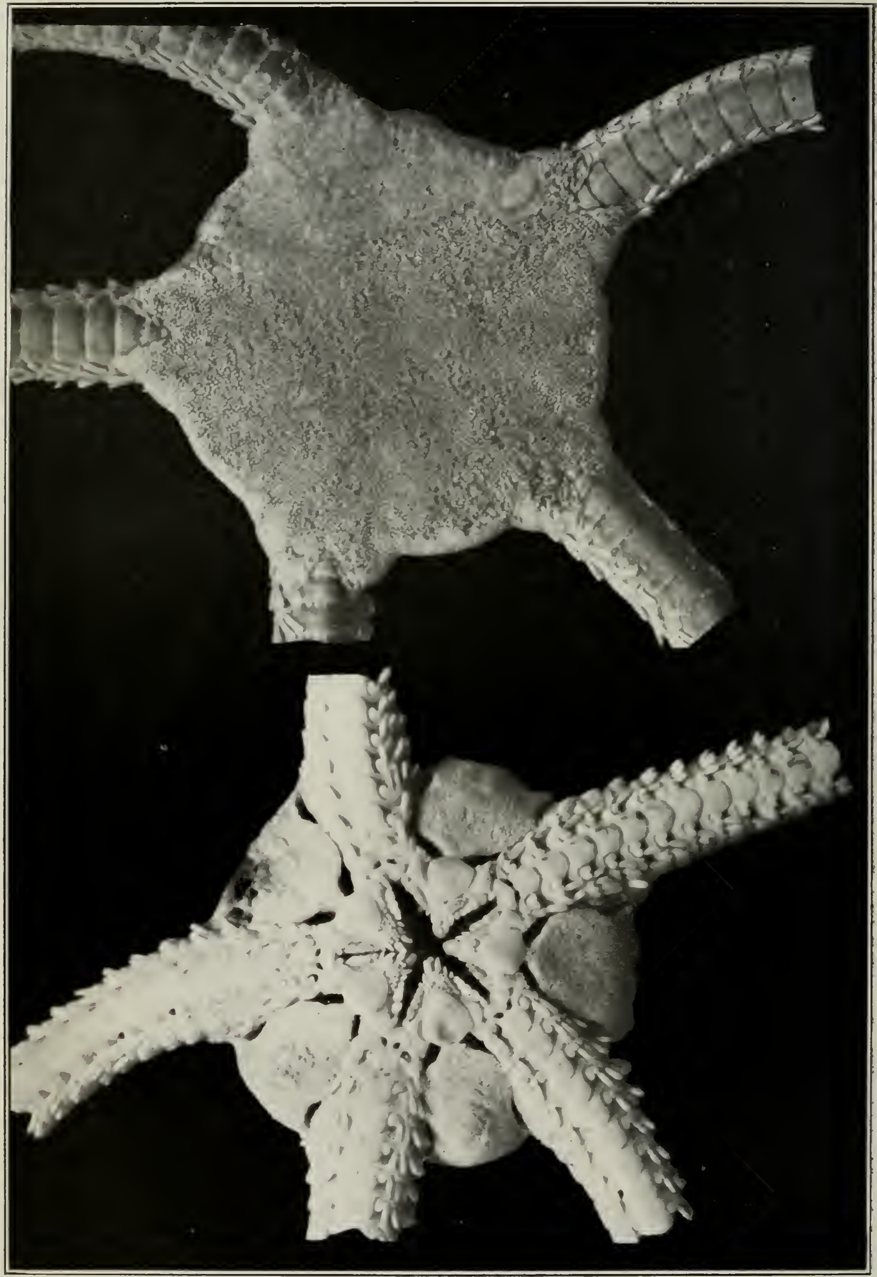

PLATE XIV. Skeleton of Ophiuran, *Ophiura brevispina*. (Five times natural size.)

commonly bear conspicuous spines, termed arm spines. The number of spines is nearly constant on the corresponding parts of the arms in all individuals of the same species, and moreover each species presents its own peculiarities in the size, position, and arrangement of these structures, as is shown on Plates XIII and XIV. Hence their importance in the diagnosis of the species.

**Tube-feet.**—The tube-feet are small and inconspicuous, and, as they have no sucking disks nor ampullæ, they are of comparatively little importance in the locomotion of the animal. They function largely as sense organs, and are therefore often called tentacles. They are also of service in respiration by the exchange of gases which takes place between their fluid contents and the external sea water, and in some cases they aid in passing food particles to the mouth. In certain species the greater portion of the food consists of small organisms which are secured by the tentacles as the slender arms are swept back and forth on the surface of the sand or mud. The food secured is passed along from one tentacle to the next until, on reaching the proximal tentacles, it is pushed between the jaws and into the mouth.

The tentacles protrude between the lateral plates of the arm, and are protected by delicate scales, called the tentacle scales (Plates XIII and XIV, and Fig. 9).

**Internal structure of Arms.**— The arm of the ophiuran is morphologically equivalent to that of the starfish, but the structures have undergone great modification. Instead of a broad

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EXPLANATION OF PLATE XIV. Skeleton of Ophiuran, *Ophiura brevispina.* (Five times natural size.)

Photographs of dried specimens, showing aboral and oral surfaces of disk and bases of rays. In the upper figure the granules covering the surface of the disk have been removed on the side toward the top of the page to show the underlying radial shields and other plates.

The lower figure shows the plates around the mouth and on the under side of the rays. Of the five large oral shields the one on the lower right-hand side is somewhat larger than the others, and is the madreporic plate. The adoral plates lie close beside the oral shields. The figure shows the teeth at the apex of the jaws, and the seven oral papillæ on each side of each jaw. The left side of the mouth shows the position of the jaws when closed. The two pairs of large openings near the base of each arm are the genital slits. On the arms the upper and under arm plates, the tentacle scales, and the closely appressed arm spines are shown.

central cavity occupied by the digestive and reproductive organs, the body cavity in the arm of the ophiuran is represented only by a narrow canal (Fig. 10). Each arm is made up of a great number of similar segments. The bulk of the arm consists of a series of solid, cylindrical disks, called vertebræ, which are arranged end to end in a single row, and taper gradually to the tip of the arm.

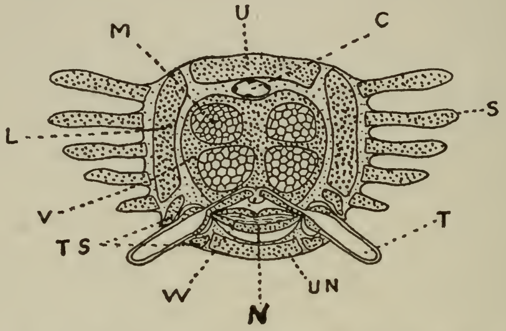

Fig. 10. Diagram of transverse section of arm of an ophiuran. *C,* branch of cœlom; *L,* lateral arm plate; *M,* muscular attachment of vertebra; *N,* radial nerve; *S,* arm spines; *T,* tentacle; *T S,* tentacle scales; *U,* upper arm plate; *U N,* under arm plate; *V,* vertebra; *W,* radial canal of water-vascular system. (Modified from MacBride.)

Each vertebra, in all our native species, articulates with its neighbor by a ball-and-socket joint, the concavity on the proximal side interlocking with a corresponding projection on the distal side of its neighbor.

The vertebræ are joined to each other by four strong muscles (Fig. 10), attached symmetrically to their faces. The contraction of the two upper muscles of a series of segments bends the arm upward; a similar contraction of the lateral or lower pair bends the arm sidewise or towards the oral surface as the case may be. By suitable combinations of such muscular contractions the arms can be moved rapidly and bent about in all possible directions, with the one exception that they are so articulated that they cannot be coiled in a spiral above the disk.

On the aboral side of each vertebra (Fig. 10) is a shallow groove which contains the slender extension of the body cavity, mentioned above, although no part of the digestive or other systems extend into it.

A similar groove on the oral side of the vertebræ contains the radial canal of the water-vascular system, which is connected with each of the tentacles, as with the tube-feet of the starfish. Beneath the radial canal is the radial nerve cord and the perihæmal canal comparable to those of the starfish.

The upper arm plates cover the extension of the body cavity, just as the under arm plates cover the organs beneath the vertebræ (Fig. 10).

Viscera.— The visceral anatomy of the ophiuran is not essentially different from that of the starfish, except that the digestive and reproductive organs do not extend at all into the rays. The simple digestive organs, mouth and saccular stomach, have been described above. The water-vascular system consists, as in the starfish, of a circumoral vessel and five radial canals, connected with the tentacles of the arms. The madreporic canal is connected with the exterior by one or more minute pores situated on one of the oral shields.

The nerve ring and its branches and the perihæmal vessels have much the same situation as in the starfish, although the nerves are more highly modified by the segregation of the nerve cells into more definite centers, or ganglia.

## HABITS

The ophiurans are usually nocturnal in habit, some species hiding away in protected places during the daytime, others remaining buried in the mud. When disturbed they hastily swim or creep away. In case the irritation has been too severe some species spasmodically throw off and leave behind one or more of their arms. This causes them only a temporary inconvenience, however, for such mutilated individuals rapidly regenerate the missing parts.

Ambulacral grooves, so well developed on the oral surface of the rays in the starfish, are lacking, and the tube-feet are so little developed that the movements of the animal are controlled by the flexible, muscular arms. They provide, however, a much more rapid means of locomotion than is afforded by the tube-feet of starfishes. The ophiuran can move rapidly among seaweeds, pebbles, or other objects by the serpentine movements of these arms, and can also swim free in the water by moving a pair of arms much as we would move our own arms in swimming. When placed upon its aboral surface the animal can quickly recover its normal position.

In ordinary locomotion one or more of the arms are clasped about an object and the rest of the body drawn forward to that position, when the same or adjacent arms reach out again to an advanced position and the animal moves rapidly forward. The more posterior of the arms help push the body along at the same time that those in front are pulling.

There is no definite orientation of the body, and any of the arms may go in front, so that when the animal desires to change its direction it does not turn the body, but merely advances an arm which was previously in the rear. It may thus go in any direction without turning the body.

When spines are well developed along the sides of the arm they aid materially in furnishing a means of attachment to any desired object. The rudimentary tube-feet, or tentacles, also aid the arm in keeping its hold, although they are not provided with the sucking disks present in those of the starfish and sea-urchin.

The motion of the arms is controlled by the circumoral nerve ring. When this ring is cut, the movements of the adjacent arms are impaired; and, when it is cut between each pair of adjacent arms, coördinated movements are entirely destroyed.

The habits and response to stimuli of these animals have been the subject of much study in recent years. Cowles has recently shown* that the tube-feet are capable of selecting food materials with much precision and passing them from one tube-foot to another until the mouth is reached. Even when removed from the body the arm still reacts to food, and nutritive particles are carried from tip to base of the severed arm, while inorganic objects are seized and quickly dropped.

The ophiuran reacts positively to solid vertical walls, and the effect of such a stimulus is retained for some time, for when an animal is removed a short distance from its hiding place it moves in the direction of the same spot without error. This so-called memory of past stimulation is lost under the influence of a much stronger stimulus, such as bright light, from which the animal retreats rapidly.

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* Stimuli Produced by Light and by Contact with Solid Walls as Factors in the Behavior of Ophiuroids. *Journ. of Exp. Zool.*, vol. ix, 1910.

The behavior of the ophiuran when subjected to a great variety of artificial conditions has been studied by Glaser.* The animal's ability to solve to its advantage many of the problems set for it, such as removing rubber bands from its arms, for example, illustrates a high degree of nervous coördination.

**Regeneration.**— The rays of all our species are fragile, and are so likely to be broken off in handling, that in some species it is difficult to kill and preserve a specimen without mutilation. Some of the species voluntarily throw off one or more rays at a point close to the disk if the animal is even slightly irritated by rough handling or by being placed in a fluid not to its liking. Other forms when disturbed break off the arms piece by piece until nothing of the animal remains except the disk.

When one or more rays are accidentally or voluntarily broken off in a state of nature, the wound quickly heals and new rays grow out from the disk in place of those destroyed, as in the case of the starfish.

If a ray is broken at some distance from the disk the end is restored to the normal length. Individuals are often found, as illustrated on Plate XII, which show such rays in process of regeneration. If the disk is cut in two each part is capable of regenerating a complete animal.

Certain species, such as *Amphioplus abditus,* have the remarkable habit of throwing off the disk when strongly stimulated, leaving only the mouth frame attached to the arms. Under favorable conditions the missing parts can be regenerated. In *Amphipholis squamata,* in which the young develop in the genital bursæ, this process of throwing off the disk is said to be the normal method by which the young are discharged.

## FOOD

Because of their secluded and nocturnal habits it is difficult to determine the exact nature of the food on which the ophiurans subsist. The animals are seldom seen to take any food whatever when kept in an aquarium, but an examination of the contents of their stomachs often reveals fragments of the indigestible parts of small crustaceans and other animals. Since it seems doubtful if the ophiuran would be able to capture these animals alive, it is believed that it acts mainly as a scavenger, taking into the large saccular stomach all sorts of dead animal matter and digesting out the substances capable of assimilation. Those parts which cannot be digested are thrown out of the mouth opening.

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* Movement and Problem Solving in Ophiura. *Journ. of Exp. Zool.,* vol. iv, 1907.

Probably the greater part of the food of many species consists of the superficial layer of organic matter which covers the rocks and floor of the sea in all situations not accessible to waves and currents. The diatoms and other minute organisms contained therein are passed toward the mouth by the tube-feet of the arms.

Some species crawl about on the sea-bottom sweeping the arms back and forth in search of food materials. Other species, such as *Amphioplus abditus,* lie for a time buried in the mud with one or more of the extremely slender arms protruding above the surface of the mud. The tube-feet (tentacles) of these arms select the food particles within reach and pass them to the mouth.

## REPRODUCTION

The reproductive organs consist ordinarily of five pairs of genital glands, situated on the walls of five sacs called the genital bursæ, which open to the exterior of the body by five or ten pairs of large slits situated on the oral surface of the disk close beside the bases of the rays. These openings are called the genital slits, and are usually quite conspicuous (Fig. 9 and Plate XIV).

The sexes are usually separate, all the glands in one individual producing eggs and in another spermatozoa. In the little *Amphipholis squamata,* however, one of the glands of each genital bursa produces eggs while the other forms sperm cells.

The sexual products when ripe break out of the sexual glands into the genital bursæ and are usually discharged directly through the genital slits, although in the above-named hermaphrodite species the eggs are fertilized and develop within the genital bursæ.

Owing to the nocturnal habits of the animals the eggs of at least some of the species are discharged in the evening; that is, between sunset and midnight. They are set free in the water and are there fertilized by spermatozoa from another individual. After fertilization the egg develops into a free-swimming ciliated larva, which by a complicated metamorphosis gives rise to the young ophiuran as described in the following chapter.

The genital bursæ are thin-walled sacs; and, as the sea water contained in them has free access to the exterior through the genital slits, and can be continually changed by the contraction of the disk, the bursæ serve as respiratory organs in addition to their primary function of discharging the genital products. The minute tentacles of the arms also aid in respiration.

## DEVELOPMENT

In most species of ophiurans the genital products are simply discharged into the sea water, and abandoned to their fate. In the little *Amphipholis squamata*, however, the eggs are retained within the body of the parent until the embryonic development is completed and the little ophiuran has reached the form of the adult. Moreover, in this case, a nourishing exudation is said to be poured out upon the eggs, which supplements the store of food contained in the yolk.

This species is likewise hermaphrodite, both ovary and spermary being attached to each of the genital bursæ. After the young have reached the adult form, the whole disk of the parent, with the exception of the mouth frame, may sometimes be thrown off to allow the young to escape, and then be regenerated. The breeding habits and development of this species have been studied by Fewkes* and others.

In the majority of ophiurans, the sexes are separate, the eggs being thrown out into the water, and fertilization takes place whenever suitable sperm cells are in the vicinity.

The eggs segment by a regular cleavage, as in the starfish and sea-urchin. As in these two groups, the embryos quickly develop into free-swimming larvæ, which in this class are called *plutei,* and which often feed for several weeks at the surface of the sea. As shown in Fig. 11, the plutei in no way resemble the adult, but are somewhat pyramidal in form, and often have

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* *Bull. Museum Comparative Zoology,* vol. xiii, 1887.

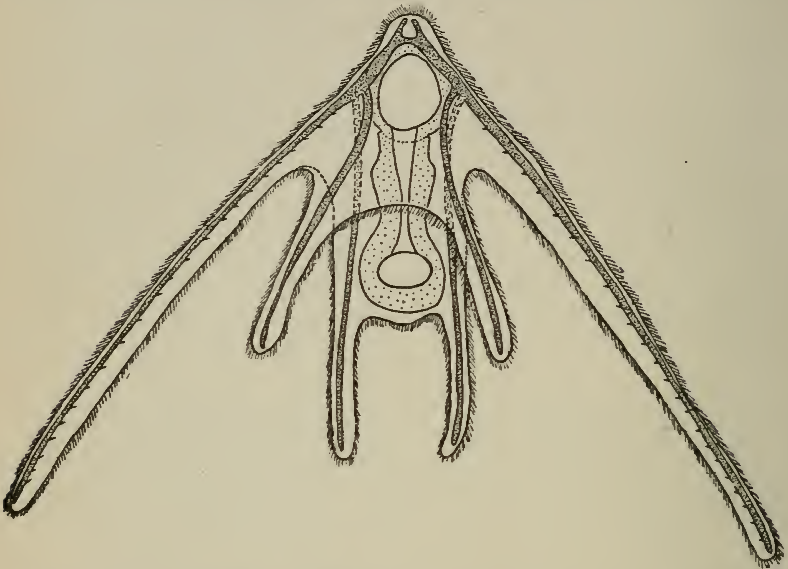

FIG. 11. *Ophiopholis aculeata.* Free-swimming larva, with long, ciliated arms. (Modified from Fewkes.)

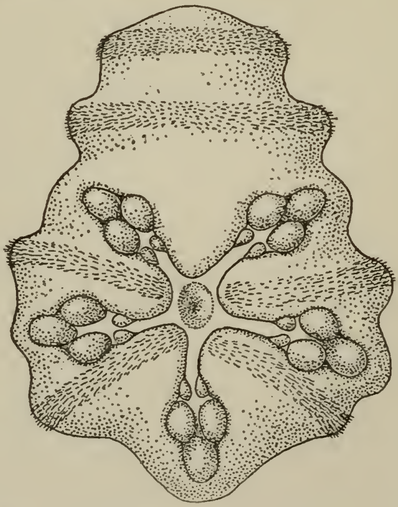

FIG. 12. *Ophiura brevispina.* Free-swimming larva preparatory to transformation to the adult form. (After Grave.)

extremely long, ciliated arms. Fig. 12 shows the larva of another species, in which there are four bands of cilia in place of the long arms. The metamorphosis is accomplished in a manner similar to that described for the starfish.

## KEY TO SPECIES

The ophiurans of the world are commonly divided into three orders, distinguished by the character of the vertebræ. Only one of these orders, the **Zygophiuræ**, with interlocking vertebræ, is represented in Long Island Sound.

1. Spines on sides of arms short, and rather closely pressed against the arms ................ **Ophiura brevispina**
   Spines projecting from sides of arms at a marked angle. . 2
2. Large median plates on upper side of arms surrounded by a series of small plates; 5 or 6 spines on each side of each joint of arm .................. **Ophiopholis aculeata**
   Median plates on upper side of arms directly in contact; that is, not surrounded by small plates............... 3
3. With 3 tooth-like projections (oral papillæ) along each edge of each jaw; length of arms less than 10 times the diameter of disk; radial shields in close contact **Amphipholis squamata**
   With 4 or 5 oral papillæ on each edge of each jaw; length of arms more than 10 times the diameter of disk; radial shields separated ................................ 4
4. Oral papillæ 4...................... **Amphioplus abditus**
   Oral papillæ 5.................... **Amphioplus macilentus**

### **Ophiura brevispina** Say, var. **olivacea**

Green Ophiuran

Plate I, fig. 5; Plates XIV, XV.

This species, which was described by Say in 1825, is known in the earlier writings of Lyman and Verrill under the name of *Ophiura olivacea*. It has been found in shallow water at numerous localities along the Atlantic coast from Cape Cod to Brazil, and at Bermuda. It is sometimes found, however, at a depth of over a hundred fathoms, especially in the warmer regions.

The form occurring north of Florida is now usually considered a distinct variety, *olivacea.*

This ophiuran occurs at numerous localities in Long Island Sound, living in water but a few feet deep at low tide, and is partial to protected situations and tide pools. It is often abundant on sandy shores among the roots of eelgrass. In such places the bottom is often covered with a mass of dead grasses and algæ, and forms the home of numerous other small animals, such as worms, mollusks, and crustaceans. Here the ophiuran hides during the daytime and is seldom seen unless disturbed. The snake-like movements of the arms may then attract attention, but the color of the animal when resting agrees most closely with that of the surrounding objects, and the appearance of the arms is quite similar to that of fragments of the stems of the eelgrass.

The color is commonly greenish or brownish but is sometimes nearly black. Olive-green individuals are perhaps the most common. The disk is often mottled and the arms banded with light and darker shades, but the colors are always dull and inconspicuous.

The disk is usually 10 to 15 mm. in diameter, and the arms 40 to 60 mm. in length. The arms are rounded and moderately slender, as indicated on Plates I and XV. Each segment of the arm has seven or eight short spines on each side, and these lie closely appressed to the arm, so that they are quite inconspicuous, as shown on Plates XIV and XV.

A most interesting account of the habits and development of this species has been published by Grave.*

### Ophiopholis aculeata (Linnæus)

Daisy Brittle Star

Plates XII, XIII, XVI.

This is without question the most beautiful and most conspicuous of all our native ophiurans, but unfortunately it is but rarely found in Connecticut waters, and there occurs only in the deeper areas toward the eastern portion of Long Island Sound. North of Cape Cod the species is very abundant and is there

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* Ophiura brevispina. *Mem. Nat. Acad. Sciences,* vol. viii, 1899.

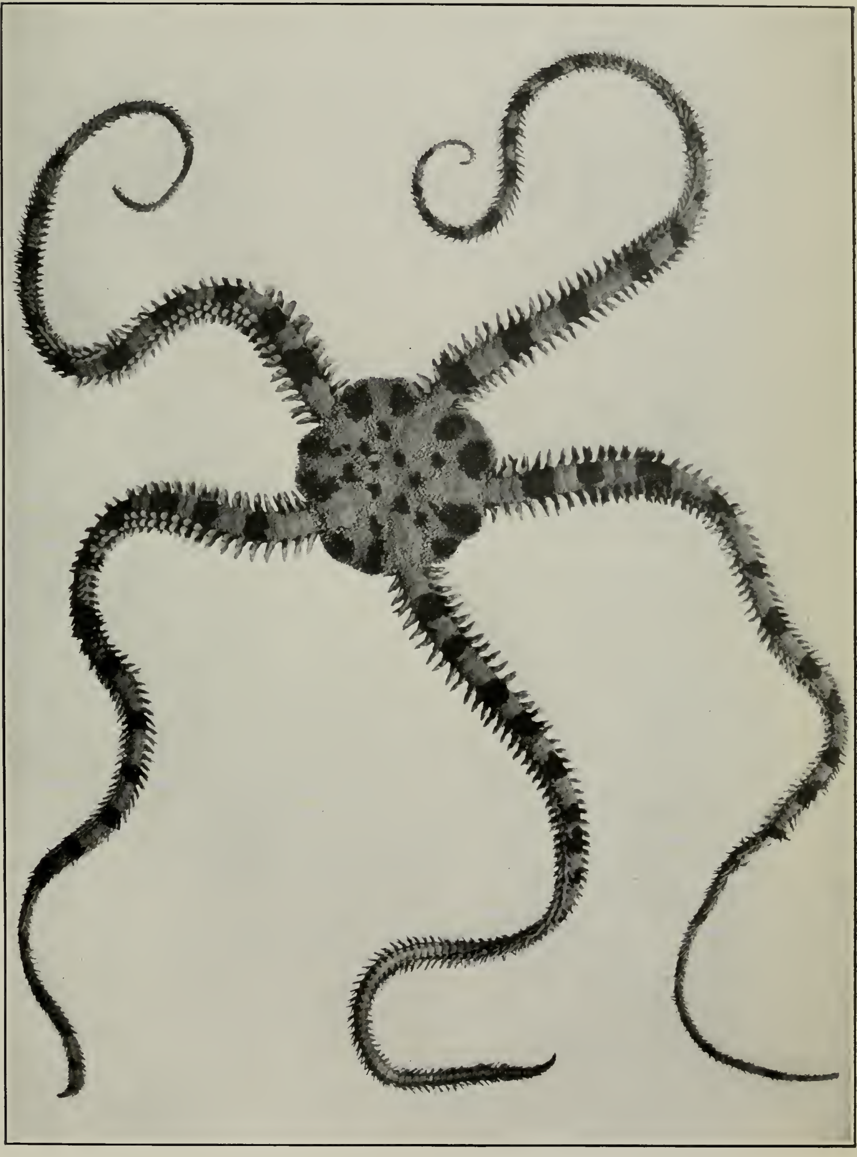

PLATE XVI. Daisy Brittle-star, *Ophiopholis aculeata*. (One and one-half times natural size.)

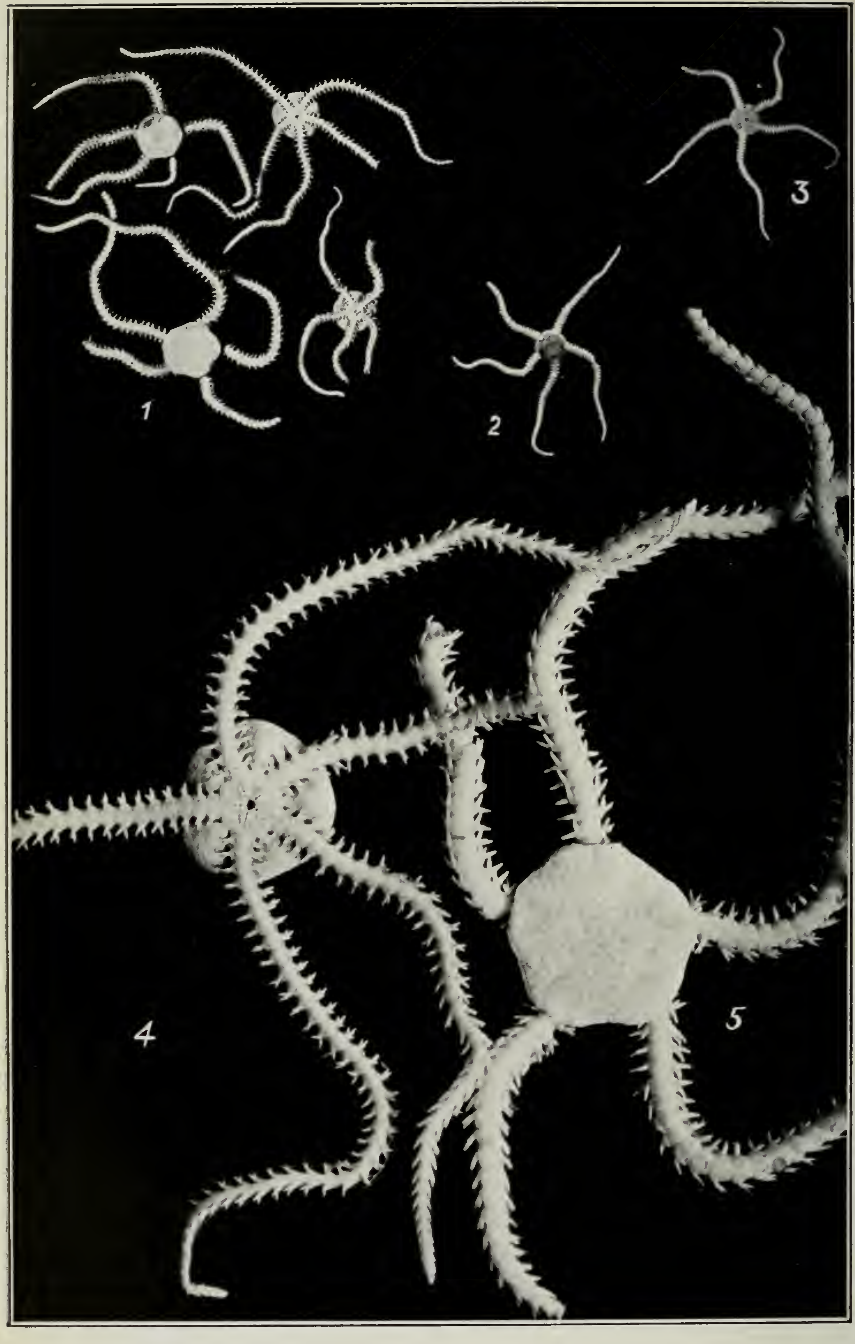

PLATE XVII. *Amphipholis squamata.* (Fig. 1, one and one-half times natural size. Figs. 2 and 3, natural size. Figs. 4 and 5, ten times natural size.)

commonly known as the "daisy brittle star." It extends northward to the Arctic Ocean, and on the European coast reaches southward as far as the English Channel. It is larger than any other of our species, the disk often being 15 to 20 mm. in diameter, and each of the arms 50 to 80 mm. in length.

The colors are exceedingly variable, not only in hue but also in the arrangement of the patterns. There are all shades of red, purple, brown, yellow, and green. The disk is spotted and blotched in some regular pattern arranged either radially or concentrically or both, while the arms are either banded or striped lengthwise (Plate XII.) The bright colors are limited to the aboral surface, the under side of disk and arms being commonly gray or yellowish, except that the dark bands on the arms often extend more or less completely over the oral surface. Of a hundred individuals taken at random scarcely two will agree closely in both shade and arrangement of markings, so that the individuality of the representatives of this species of ophiuran is more conspicuous than in almost any other invertebrate.

### Amphipholis squamata (Delle Chiaje)

Plate XVII.

This is the smallest species of ophiuran recorded on our coast, and it is also the most abundant and the most widely distributed. On the Atlantic coast of America it occurs from the Arctic Ocean to the coast of New Jersey, and it is also found on the northern coasts of Europe and in the Mediterranean Sea. In America the species is often referred to under the name of *Amphipholis elegans* or *Amphiura elegans*, and in Europe is sometimes called *Amphiura squamata.*

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Explanation of Plate XVII. *Amphipholis squamata.*

Fig. 1. Four specimens showing both oral and aboral surfaces. The tips of several of the very fragile rays have been broken off. One and one-half times natural size.
Fig. 2. Aboral surface. Natural size.
Fig. 3. Oral surface. Natural size.
Fig. 4. Oral surface. Enlarged ten times.
Fig. 5. Aboral surface, showing the smooth scale-like plates which cover the disk. The narrow radial shields are in close contact with each other. Each segment of the arms has three arm spines on each side. Enlarged ten times.

(Figs 2 and 3 from photographs loaned by the U. S. Fish Commission, with permission of Dr. H. L. Clark.)

In Long Island Sound this ophiuran occurs on the eelgrass in New Haven harbor, and has been collected at several other localities in shallow water, hiding in dead mollusk shells and in the interstices of stones.

The diameter of the disk is 3 to 5 mm., and the length of each of the five slender arms is from 10 to 20 mm.

The color is gray or pale brownish, often with numerous lighter or whitish spots. The oral surface is gray with a yellowish tinge, usually with a whitish spot at the base of each arm. In very young specimens the disk is orange.

The disk is flattened and nearly circular (Plate XVII), and is covered with small scales. The arms have three spines on each side of each segment, and these stand out at nearly right angles to the axis of the arm, as shown in the figure.

A detailed description of the arrangement of scales on disk and arms is to be found in Clark's Report on the Echinoderms of the Woods Hole region.*

In this species the eggs mature in midsummer and are retained in the genital bursæ after fertilization. They there develop into young ophiurans, which are then discharged from the body as tiny brittle stars, of form and structure like the parent. They do not undergo the metamorphosis characteristic of the other species, for none of our other species is known to be viviparous.

### **Amphioplus abditus** Verrill

Plate XVIII; Plate XIX, fig. 1.

This locally distributed species was for many years known only from Long Island Sound. Quite recently, however, a single specimen has been recorded from the harbor at Woods Hole, Massachusetts,† and one specimen was collected by the writer some years ago at the same locality.

The animal lives buried in the soft mud, and when exposed quickly buries itself again. Verrill‡ states that it naturally lies with one or more of the very slender arms projecting above the surface of the mud. "On this account it is seldom dredged

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* *Bulletin U. S. Fish Commission* for 1902, p. 560.

† H. L. Clark, *Science*, vol. xxvii, p. 147, 1908.

‡ Invertebrate Animals of Vineyard Sound, p. 139.

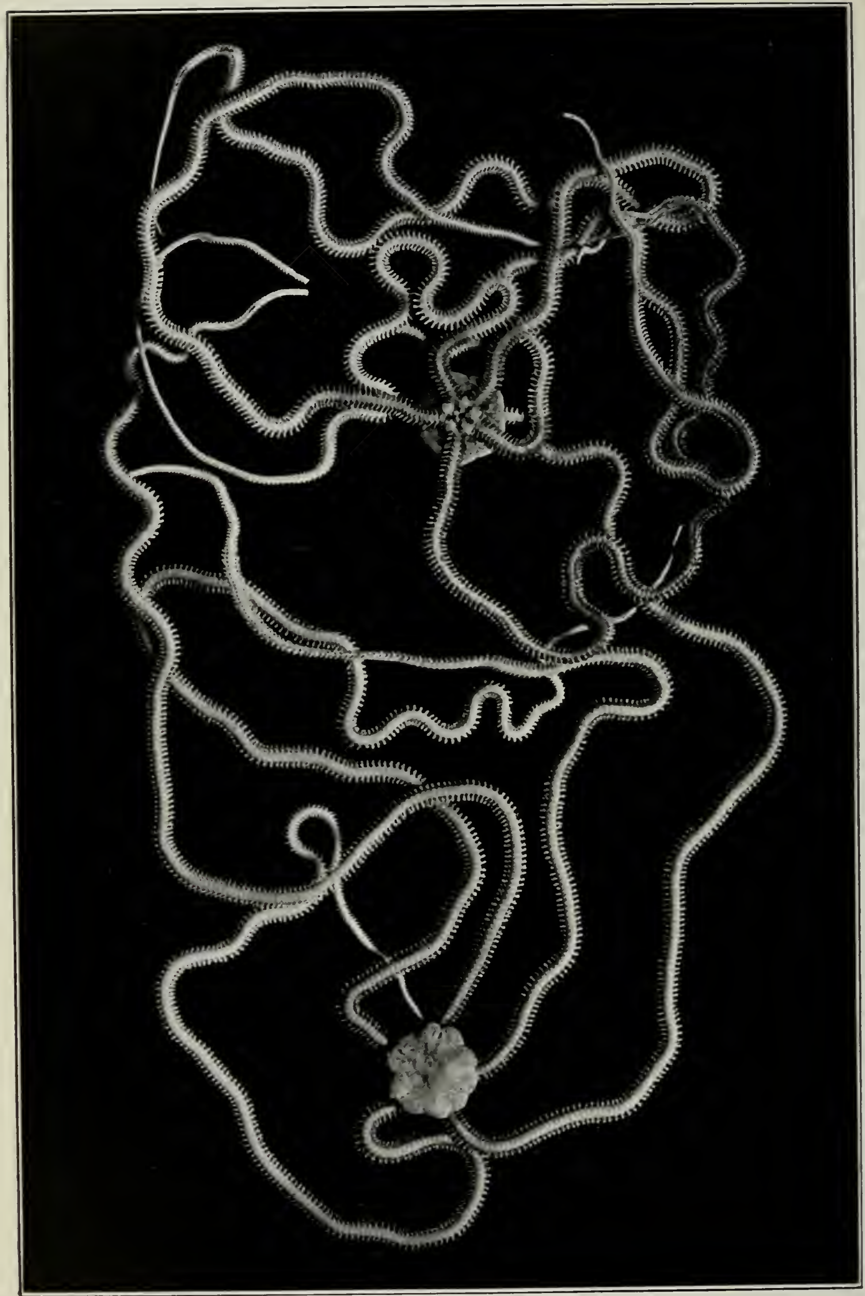

PLATE XVIII. *Amphioplus abditus.* (Slightly enlarged.)

Two individuals, showing both oral and aboral surfaces of disk, and the extremely slender rays.

entire; the projecting arms are usually cut off by the dredge, and the animal escapes; and as it has the power of restoring lost arms, this is only a temporary inconvenience. The same thing probably happens when a voracious fish seizes one of the arms."

The specimens from Woods Hole were collected at extreme low-water mark. In Long Island Sound the species has been dredged off New Haven and at Thimble Islands at depths of from three to eight fathoms, and many specimens have been collected in soft mud, near low-water mark, at Noank, Connecticut, and others at Peconic Bay, Long Island.

The disk of mature individuals measures from 6 to 11 mm. in diameter. The arms are very slender and extremely flexible. They are usually from twelve to sixteen times as long as the diameter of the disk, and sometimes measure as much as 180 mm. in length.

In addition to the extremely long and slender arms (Plate XVIII, Plate XIX, fig. 1), the species may be distinguished by other anatomical peculiarities. Careful examination of the jaws will show the presence of four tooth-like processes, oral papillæ, on each edge. On the sides of each segment of the arm is a series of three projecting spines, of which the middle one is stouter, flatter, and less pointed than the other two.

On the aboral side of the disk at the base of each arm is a pair of narrow plates, called the radial shields. In the present species these are narrow, curved, and parallel or only slightly divergent, and not closely in contact. They are often partly covered by the encroachment of the small scales which cover the disk. The scales of the disk are without granulations or spines.

The color of the living animal varies considerably in different specimens. Some are brown on the aboral surface of the disk, with a central area of dark brown bordered by pale gray. A radiating band of dark brown likewise bordered by gray extends outward to each interradial margin. The radial shields are yellowish brown, while the narrow space between them is blue. There are additional symmetrically placed brown spots arranged in series on the disk. The arms are brown or dull greenish, often with lighter bands. The specimen from Woods Hole studied by Clark was uniformly gray.

The animals have remarkable powers of regeneration, for they have the habit of throwing off the disk when violently disturbed, leaving only the mouth frame and adhering organs attached to the arms. Under favorable conditions they are able to regenerate the missing disk, and specimens have been collected in which such regeneration was actually in progress.

Full details of the anatomical peculiarities are given in Verrill's original description of the species.*

The species is also fully described in Verrill and Smith's Invertebrate Animals of Vineyard Sound, page 426, although the description there given has been revised in certain details in a later paper by Verrill.†

### **Amphioplus macilentus** Verrill

Plate XIX, fig. 2.

This species is closely related to the preceding, but is distinguished by having five oral papillæ in each row, and the spines at the sides of the arms are all slender.

Although this species has not yet been recorded from Long Island Sound, it has been collected at various localities so near the eastern entrance to the Sound as to render it highly probable that further investigation will reveal its presence in Connecticut waters. It has been dredged by the United States Fish Commission in muddy localities at numerous stations off the southeastern coast of New England, and in certain places occurs in large numbers as far south as Cape Hatteras.

Full details of the anatomical peculiarities are given in Verrill's original description of the species.‡

The individuals belonging to this species are small, with very long and slender arms (Plate XIX, fig. 2). The disk is

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* *Am. Journ. Sci.*, 3rd series, vol. ii, p. 132, 1871.

† North American Ophiuroidea. *Trans. Conn. Acad.*, vol. x, p. 314.

‡ *Am. Journ. Sci.*, 3rd series, vol. xxiii, p. 142, 1882.

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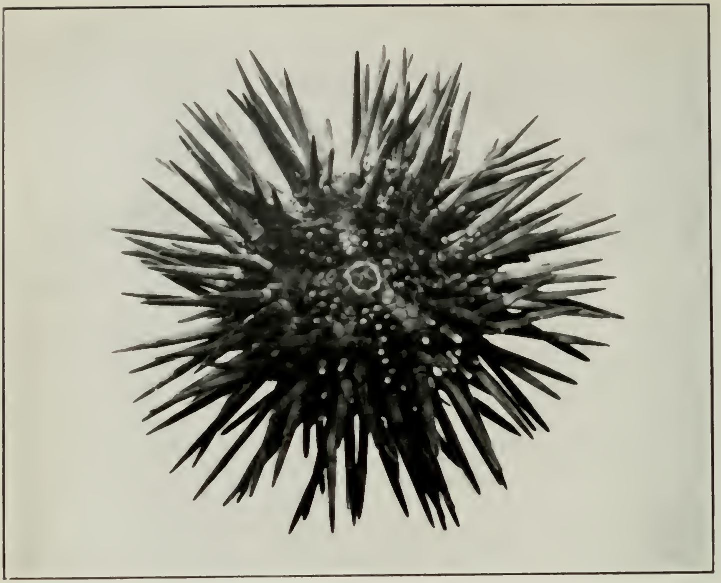
EXPLANATION OF PLATE XIX.

Fig. 1. *Amphioplus abditus.* Oral surface of disk and portions of rays. One of the extremely slender rays is in process of regeneration. Three times natural size.

Fig. 2. *Amphioplus macilentus.* Oral and aboral surfaces, showing the extreme slenderness of the rays. Twice natural size.



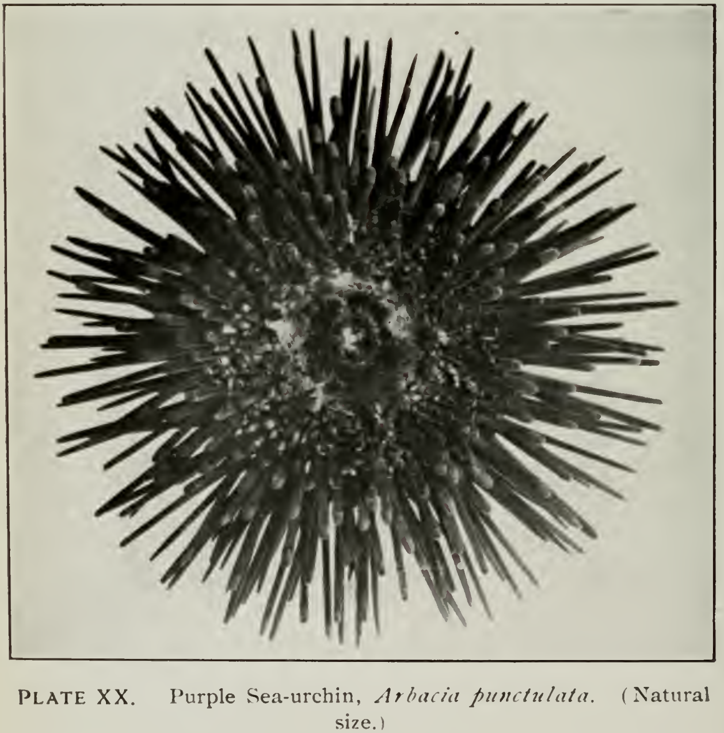


PLATE XX. Purple Sea-urchin, *Arbacia punctulata*. (Natural size.)

nearly circular in outline in the living animal, but often becomes pentagonal when preserved in alcohol or dried. The aboral surface of the disk is covered with numerous, small, naked, imbricated scales, forming a rather distinct rosette at the center. The radial shields are long and narrow, with their outer ends in contact, and their inner ends separated by a narrow wedge of small scales. The oral surface is covered with more minute scales than those of the aboral surface. The oral shields are shield-shaped, rather longer than wide.

The five oral papillæ are unequal in size, but all are obtusely rounded. The inner one is the largest and stoutest, while the next is the smallest and most acute; the next two are flattened, while the outermost is small and rounded.

The under arm plates are shield-shaped and longer than broad. Near the base of the arms they are in contact, but farther out they are separated by the side arm plates. Tentacle scales two. Arm spines three, nearly equal, about as long as the joints.

Color light gray. Diameter of disk about 4 mm. Length of the extremely slender arms about 60 mm.

## CLASS III. ECHINOIDEA

This class includes the animals popularly known as sea-urchins, sand-dollars, cake-urchins, disk-urchins, sea-cakes, and sand-cakes. In the sea-urchins the body is nearly hemispherical, while the others are flattened and discoid. Spines thickly cover the body on all sides, except sometimes at the poles. In one of our species (*Mellita pentapora*) the disk is pierced by five oval perforations.

### STRUCTURE

If the purple sea-urchin (*Arbacia punctulata*) be taken as an example of this group, the body is seen to be enclosed in a

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Explanation of Plate XX. Purple Sea-urchin, *Arbacia punctulata.* (Natural size.)

The larger specimen (lower figure) shows the oral surface, with the five sharp white teeth in the center; while the smaller specimen (upper figure) shows the aboral surface, in the center of which is the periproct, surrounded by a broad area free from spines. (After Clark.)

firm, hemispherical shell made up of 20 meridional rows of closely fitting plates, and with a wide circular aperture at one pole (Plate XXV). In a living specimen of this same species (Plate XX), the shell, or test, is so thickly covered with long stiff spines as to obscure its surface completely except at the poles.

At one pole of the body may be seen the five sharp, calcareous teeth surrounding the mouth. This is therefore the oral, or actinal pole of the body; the opposite pole being aboral, or abactinal. Around the mouth is a broad area devoid of large spines, called the peristone. It consists of a strong membranous wall with an abundant musculature, enabling the mouth to be opened and closed. The peristome is provided with numerous slender pedicellariæ, which differ from those of the starfish in having three blades, which form the angles of a triangle. Similar pedicellariæ are scattered over the body. The circular lip surrounding the teeth can close the mouth very tightly (Plate XX).

At the aboral pole there is likewise a considerable area (Plate XX) devoid of spines, in the center of which is a cluster of movable plates (Fig. 13) constituting the periproct. The intestine opens in the center of the periproct. In the species under consideration the periproct consists of four triangular plates, while in the other native species of sea-urchin (*Strongylocentrotus dröbachiensis*) there are many minute plates (Plate XXI). The spines which cover the surface of the test vary somewhat in shape, but all are cylindrical, solid, and longitudinally fluted. These spines not only constitute a very formidable defensive covering, but are used in locomotion. Some of the spines nearest the aboral pole are sharply pointed, while others are blunt; below the equator of the test the tips of the long spines are somewhat flattened and rounded, while those nearest the peristome are short, and spatula-like, with flattened, rounded tips (Plate XX).

The base of each spine has a rounded socket which fits closely against a corresponding hemispherical tubercle on one of the plates of the test, allowing a great range of movement. Closely fitting this ball-and-socket joint is a wreath of muscular fibers attached both to test and spine. These muscles are able to move the spine in all directions. Beneath these "moving" muscles is a wreath of specialized muscle fibers whose function is, when stimulated,

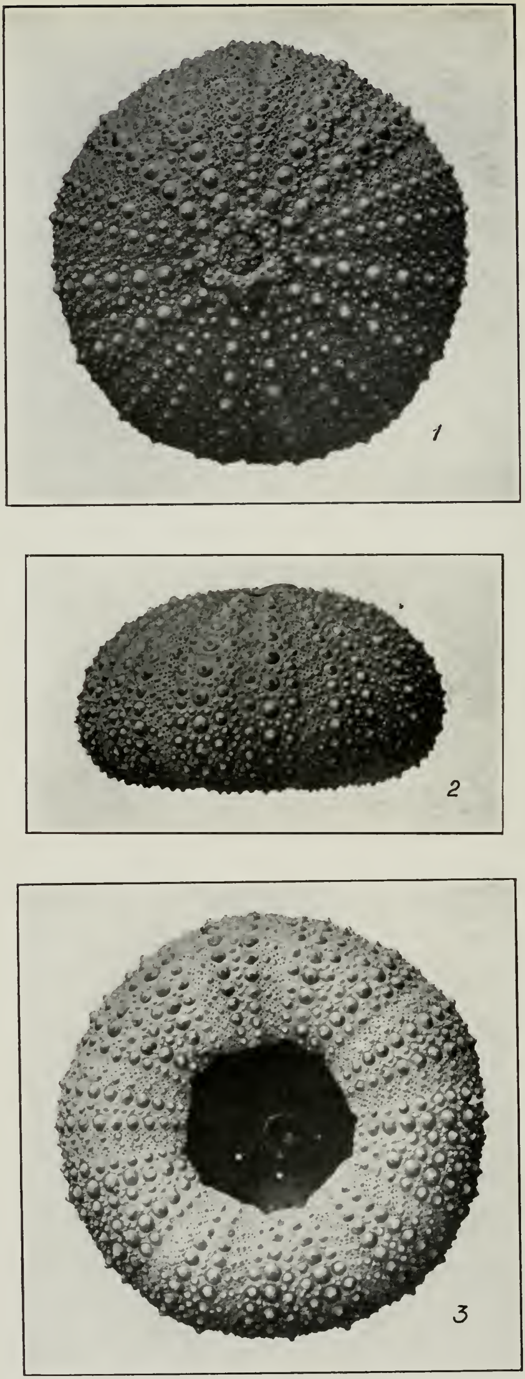

PLATE XXI. Skeleton of Sea-urchin, *Strongylocentrotus dröbachiensis.* (Natural size.)

to set the spine stiffly in one direction. As long as the action of this muscle lasts the spine can only be moved by tearing the muscle.

The test denuded of spines (Plate XXV) shows clearly the regularity with which the spines are arranged, each tubercle indicating the position of a spine. In *Strongylocentrotus* there are numerous smaller secondary spines between the larger ones, as shown by the smaller tubercles (Plate XXI). In this genus there are several times as many spines as in *Arbacia.*

Both the tube-feet and the spines assist in locomotion, as described below.

An examination of a living specimen shows five pairs of meridional groups of very slender tube-feet, which are capable of expanding to great length. The extremity of each tube-foot on the oral surface has a sucker-like expansion, kept open by a perforated calcareous plate. The position of the tube-feet is indicated in the denuded test (Plate XXV) by the ten series of plates with minute perforations. These ten series of openings correspond with the groups of tube-feet seen in the living animal, each pair of openings representing the position of a single tube-foot.

The series of ten rows of plates which bear the tube-feet constitute the five ambulacral, or radial areas, there being two rows of plates to each. Between the ambulacral areas are five interambulacral, or interradial, areas of about equal extent. Each of these five areas likewise consists of two meridional rows of plates (Fig. 13).

The ambulacral areas may thus be seen to represent the oral surfaces of the arms of the starfish, bent upward in a semicircle, while the interambulacral areas correspond to the sides of the

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Explanation of Plate XXI. Skeleton of Sea-urchin, *Strongylocentrotus dröbachiensis.* (Natural size.)

Figs. 1 to 3. Aboral, lateral, and oral surfaces with spines removed, showing the regularly arranged rows of larger and smaller tubercles which in life bear the primary and secondary spines respectively. Scattered among the larger tubercles are numerous minute tubercles which bear the miliary spines. The oblique rows of minute dots arranged in pairs represent the pores for the tube-feet, and indicate the position of the five double rows of plates of the ambulacral areas. Of about equal extent are the five interambulacral areas. In Fig. 1 the centrally placed periproct, consisting of many minute plates, is surrounded by a circle of larger ocular and genital plates. In Fig. 3 the peristome and jaws have been removed.

arms, firmly fitted together. Thus the entire aboral surface of both disk and arms of the starfish can be represented in the sea-urchin only by the few plates of the periproct.

Each ambulacral area ends near the periproct in a single plate called the ocular plate (Fig. 13), perforated by a pair of minute openings from which a tentacle protrudes, as at the end of the arm of the starfish. The interambulacral areas likewise terminate in single large plates called the genital plates, because they bear the five openings of the genital glands (Plate XXV). One of these genital plates is larger than the others, and is perforated by numerous minute pores which lead to the water-vascular system. This plate is therefore termed the madreporic plate (Fig. 13).

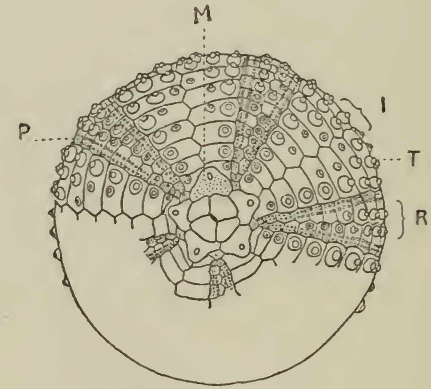

FIG. 13. *Arbacia punctulata.* Outline of plates of aboral surface, showing the four plates of the periproct, surrounded by the five ocular and five genital plates at the ends of the ambulacral (*R*) and interambulacral (*I*) zones, respectively; the genital plate marked *M* is the madreporic plate; *T*, tubercles for attachment of spines; *P*, pores for the tube-feet.

At the margin of the peristome are five pairs of much branched processes, having a respiratory function, and termed the dermal branchiæ, or gills.

Just inside the test at the border of the peristome, and resting upon the bases of the ambulacral areas, are five pairs of calcareous

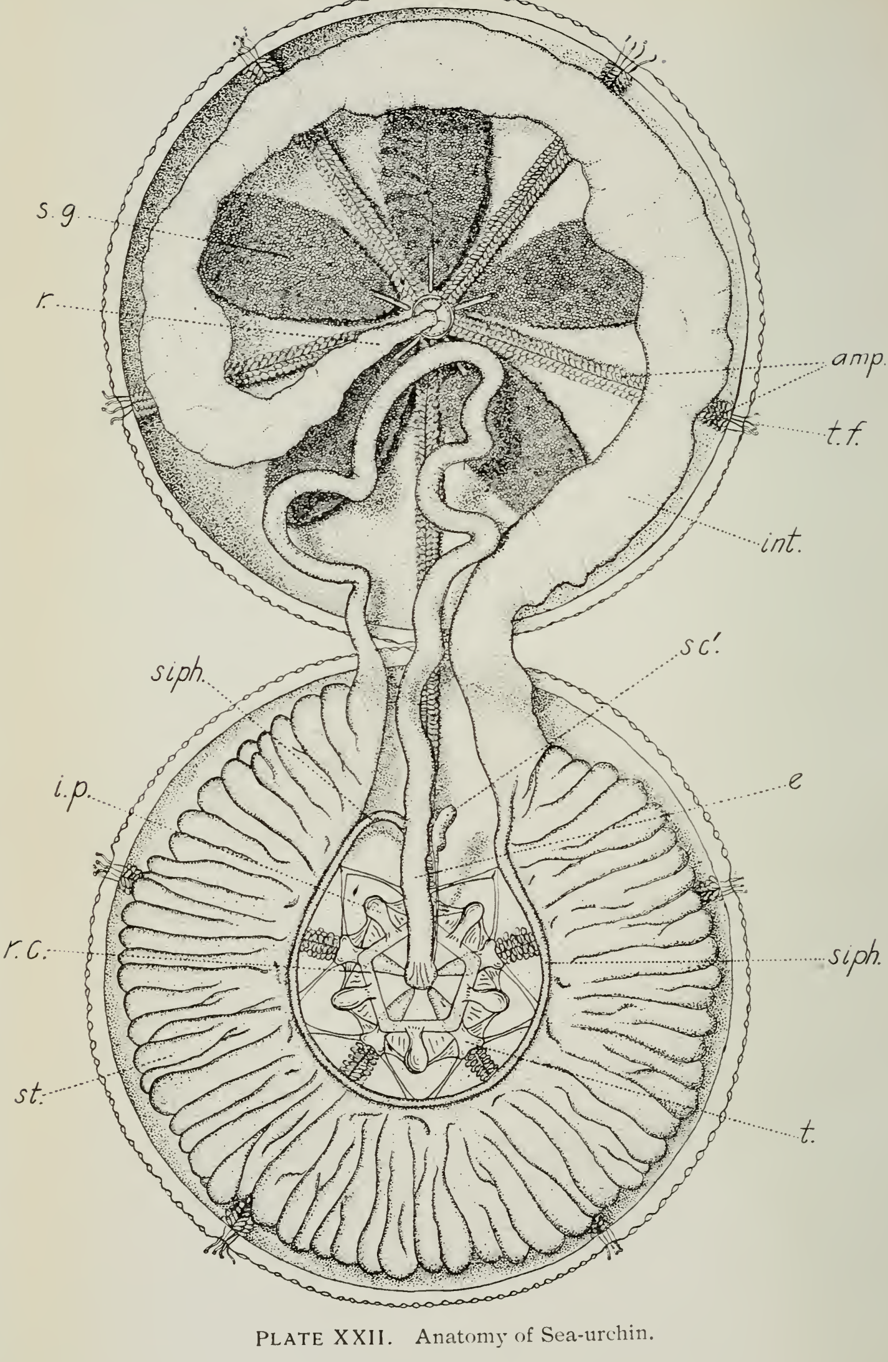
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PLATE XXII. Anatomy of Sea-urchin.

pillars, the auricles, to which are attached the powerful muscles for protruding and retracting the jaws. In *Strongylocentrotus* the pillars of each pair are connected by a bridge.

Internal Anatomy.— If the test is cut through at the equatorial region, and the two portions laid side by side without injuring the alimentary canal, the internal organs of the sea-urchin are easily studied. The more prominent organs to be seen in such a dissection are shown on Plate XXII.

Digestive System.— In the sea-urchin, the mouth, situated in the center of the oral surface, is provided with five sharp calcareous teeth which meet closely in the axis of the body and close the mouth completely. These teeth are set in jaws which are moved by a complicated set of muscles attached to a calcareous frame-work; this, with the attached teeth, is often called the lantern. When the jaws are separated the mouth presents a wide opening leading into the esophagus. The latter is short, and at its end divides into two branches, of which one is coiled irregularly for some distance and opens into the wide, saccular stomach, while the other forms the siphon (Plate XXII).

The stomach is broad and flat; its walls are irregularly constricted to form numerous sac-like pouches which greatly increase the surface area. It makes a nearly complete circle at the equator of the body and then bends sharply upward and passes into the narrower intestine. The intestine is also flat, and at its beginning bends directly backwards and encircles the body. Its course lies parallel with the stomach but it leads in the opposite direction.

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Explanation of Plate XXII. Anatomy of Sea-urchin. *Arbacia punctulata,* showing the arrangement of the internal organs. The test has been cut horizontally and the two parts laid side by side without cutting the alimentary canal; the upper circle representing the aboral portion of the test and the lower circle the oral part. At the center of the lower section the mouth opens into the esophagus (*e*) from which the spihon (*siph*) and stomach (*st*) branch out. The intestine (*int*) in the upper section lies parallel with the stomach in its natural position, but its course is in the opposite direction. The rectum (*r*) opens through the anus at the center of the upper section. The five sexual glands (*s. g*) open by narrow ducts on the aboral surface near the anus. The five teeth (*t*) lie at the five angles of the mouth. The ring canal (*r. c*) with the five interradial pouches (*i. p*) are shown. Beside the esophagus lies the delicate madreporic canal with its dorsal ampulla (*s. c′*) although the connection of the latter with the aboral surface has necessarily been torn away. The rows of ampullæ (*amp*) and tube-feet (*t. f*) connected with the radial canals are shown in both sections.

After making a nearly complete circle, the intestine passes gradually into the rectum, which bends obliquely upward and opens to the exterior in the center of the aboral surface.

The siphon makes a short cut between the esophagus and the posterior end of the stomach. It consists of a narrow tube imbedded in the inner wall of the stomach, and is lined throughout with a strongly ciliated epithelium, which presumably draws a stream of water from the esophagus to the intestine. This water doubtless aids in respiration, and may also serve to wash indigestible food materials out of the alimentary canal.

The food of the sea-urchin consists of seaweeds and various small animals. Some species devour such dead animal matter as can be obtained, individuals sometimes collecting in numbers on the body of a dead fish. The organic matter on the surface of the sea bottom is also used for food, while certain species are said to capture and devour large crustaceans. The sharp chisel-like teeth would seem to fit the creature for devouring almost any kind of plant or animal matter which by its slow method of locomotion it is able to secure.

**Water-vascular System.**— From the madreporic plate, the madreporic canal leads directly down to the circular vessel, which is situated immediately above the jaws and surrounds the base of the esophagus. Connected with the circular vessel are five interradial pouches, or Polian vesicles (Plate XXII).

Five radial vessels, similar to those of the starfish, leave the circular vessel, pass to the borders of the peristome and thence along the inside of the test directly beneath the ambulacral areas, and end in the terminal tentacle of the ocular plate. The radial vessels supply the tube-feet as in the starfish, each tube-foot connecting with an ampulla inside the wall of the test (Plate XXII). Two perforations of the plates of the test are provided for each tube-foot, so that the contained fluid may enter the foot by one canal and return to the ampulla by the other. Internal cilia keep up this circulation of fluid, and by this means the fluid in the tube-feet is continually changing. An exchange of gases can take place between the fluid contained in the tube-feet and the sea water, and a supplementary respiration is accomplished thereby. In *Arbacia* only the tube-feet of the lower part of the body are provided with suckers and used for locomotion, those of the upper part being specially adapted for respiration, while in *Strongylocentrotus* all the tube-feet have suckers.

**Nervous System.**— As in the starfish, there is a main nerve ring surrounding the mouth, with five radial nerves which accompany the radial vessels to the base of the terminal tentacle. Each tube-foot and all the spines and pedicellariæ are supplied with branches of these radial nerves.

The tube-feet are not only used for locomotion and respiration, but are highly sensitive to various kinds of stimuli. Specialized tube-feet on the peristome enable the animal to taste. The pedicellariæ are in many species modified to perform a variety of functions, some having specialized sense organs and poison glands. Minute organs scattered over the body in many species, and known as sphæridia, are thought by some to act as balancing organs.

**Reproductive System.**— Attached by strong mesenteries to the upper wall of the test are the five sexual glands. The genital duct leading from each of these glands opens by a minute pore in the corresponding genital plate adjacent to the periproct. When fully developed the sexual glands become enormous masses of tiny follicles (Plate XXII).

The sexes are separate, but are not distinguishable externally. The females produce many thousand eggs, which are discharged into the water when mature.

**Comparison of Arbacia with other Genera.**— A comparison of our three other representatives of this class with the description given above for *Arbacia* offers many points of interest.

The green sea-urchin agrees with the purple sea-urchin in having a nearly hemispherical test, with the mouth placed symmetrically at one pole and the anal opening at the other. Both species therefore belong to the order Regularia, or radially symmetrical urchins. Both the sand-dollar and the key-hole urchin, on the other hand, have flat, discoid bodies, nearly circular in outline but with one or more slight indentations; and the key-hole urchin has five narrow oval perforations (Plate XXVIII).

In the sand-dollar and the key-hole urchin, the mouth occupies the usual position in the center of the oral surface; but in the sand-dollar the anus has been shifted to the edge of the disk (Plate XXIII), and in the key-hole urchin it is very near the mouth, on the proximal border of the middle lunule (Plate XXIV, fig. 1). In neither of these forms, therefore, is the body radially symmetrical, and they belong to the order Clypeastroidea, or disk-urchins, as they may be called.

Both these species of clypeastroids have strong jaws, with fine, sharp, calcareous teeth, but the jaws (Plate XXIV) are less complicated than in the order Regularia. The peristome is very small, so that the jaws cannot be opened so widely as in the regular forms. By means of the teeth both these species pick up particles of sand and mud, with the diatoms and other minute organisms adhering. These particles are swallowed in vast numbers, and the organic matter digested out, after which the sand is passed out of the anal opening.

Both of our species of disk-urchins are plainly bilaterally symmetrical, the mouth and anus lying in the median antero-posterior plane. This bilaterality is shown also in the outline of the body. As illustrated in Plate XXIV, the anus in *Echinarachnius* lies in an indentation at the posterior end of the disk, and there are two other slight indentations on the edge of the disk in the adjacent ambulacral areas. In *Mellita* (Plate XXVIII) the manifestation of bilateral symmetry is carried still farther, for here there are five symmetrically placed lunules, one being in the posterior interradius, while the others occupy the two adjacent radii on each side. These arise in the young urchins as notches in the edges of the test, and gradually deepen and close over as the animal increases in size. Furthermore in both species the disk is broader posteriorly, and narrower in front.

Although the anal opening has moved from its primitive position at the aboral pole, the ocular and genital plates have retained the same position as in the regular sea-urchins. They

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EXPLANATION OF PLATE XXIII. Skeleton of Disk-urchin, *Echinarachnius parma*. (Natural size.)

Aboral and oral surfaces with spines removed. The upper figure shows the ambulacral areas ("petals") and the four genital pores near the center of the disk. The lower figure shows the mouth and teeth, and the closely fitted plates. The indentation on the lower median border indicates the position of the anus.

(Photographs loaned by the U. S. Fish Commission, with permission of Dr. H. L. Clark.)

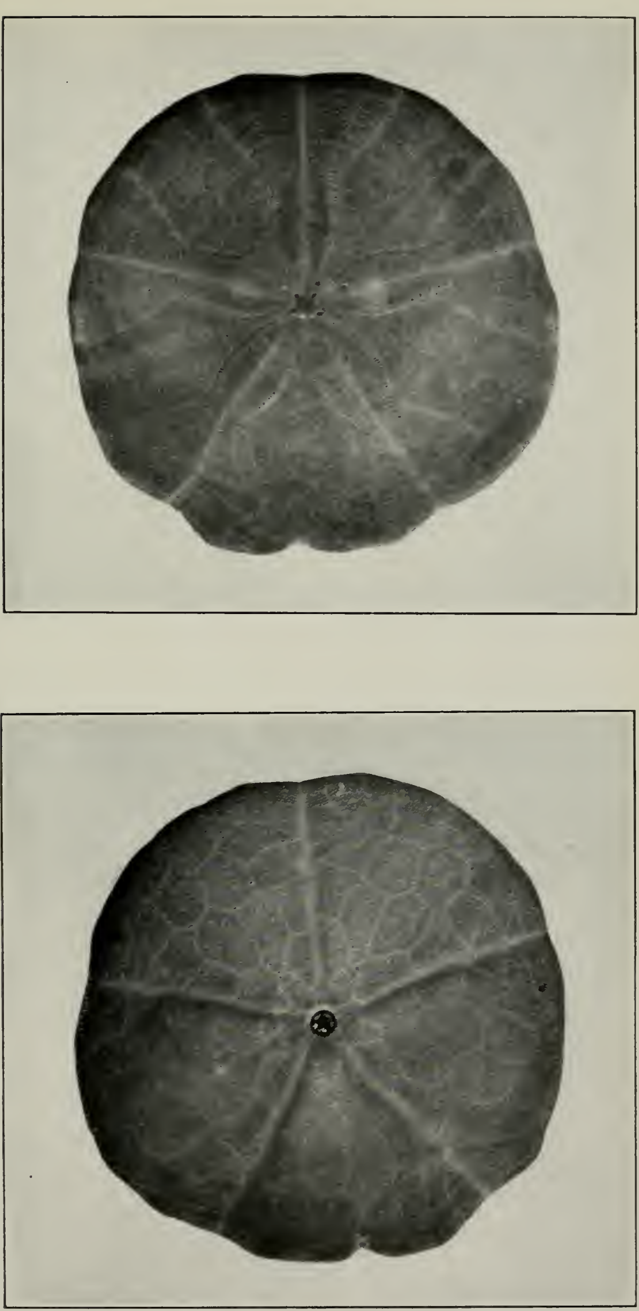

PLATE XXIII. Skeleton of Disk-urchin, *Echinarachnius parma.* (Natural size.)

here surround a single central plate, however, instead of the intestinal opening.

The ambulacral areas are plainly marked on the aboral surface of both species by the rows of respiratory tube-feet which are arranged symmetrically about the central plate. The figure thus formed has the general shape of a five-petaled flower (Plates XXVII and XXVIII), and the two groups of each ambulacral area are together called a "petal." The petals are even more clearly indicated by the rows of double pores on the surface of the disk after the removal of the spines (Fig. 14).

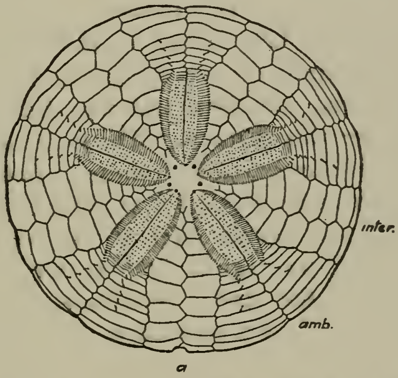

FIG. 14. *Echinarachnius parma.* Outline of plates on aboral surface; *amb,* ambulacral areas; *inter,* interambulacral areas; *a,* position of intestinal opening. The four genital pores are shown near the center of the disk.

In contrast with the large spines of our regular sea-urchins, the disk-urchins are clothed everywhere with minute, slender, brownish or purplish spines, those on the upper surface being covered with cilia, which cause currents of water to pass continually over the respiratory tube-feet.

The tube-feet in the clypeastroids are specialized either for respiration or locomotion. Those serving the latter function are scattered all over the upper surface in the interambulacral areas as well as in the ordinary position in the ambulacral areas. On the ventral surface they occur along definite grooves in the ambulacral areas, with branches extending into the interambulacral areas.

The respiratory tube-feet which mark the outlines of the petals, as stated above, are much larger than the others, and are bilobed at the base, with two fine tubes which pass through the plates of the test in the double pores of the petal. Both kinds of tube-feet bear suckers.

Correlated with this highly modified arrangement of the tube-feet is a corresponding specialization of the water-vascular system, for each foot is connected with a branch of these vessels.

MacBride* offers the following explanation of this complex system: "The condition of the water-vascular system is to be explained entirely by the peculiar environment of the animal. The demand for specialized respiratory organs is brought about by the habit of living half buried in the sand. Under these circumstances the strain of supplying the needful oxygen is thrown on the dorsal tube-feet, and they become modified in order to fit them for this function. The locomotor tube-feet are very small and feeble compared with those of *Echinus esculentus;* but this is comprehensible when it is recollected how little resistance the yielding sand would offer to the pull of a powerful tube-foot like that of the regular urchins, for in order to move the creature through the sand a multitude of feeble pulls distributed all over its surface is necessary, and the locomotor tube-feet are exactly fitted, both as to size and number, for this object." The power of movement is not wholly dependent upon the action of the tube-feet, however, for the vast number of minute spines which cover the body are freely movable and undoubtedly aid largely in the process of locomotion.

The structural weakness due to the flattened shape of the body in the disk-like urchins is compensated by strong vertical plates of calcareous material which unite the oral and aboral parts of the test so firmly, especially towards the edges, that it is difficult to break open the body except in its central portion.

**Internal Anatomy.**— The alimentary canal shows considerable modification in the disk-urchins, owing to the nature of the food and the position of the anal opening. Dissections showing the digestive tracts of the sand-dollar and the key-hole urchin are illustrated on Plate XXIV.

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* Cambridge Natural History, Echinodermata, page 547.

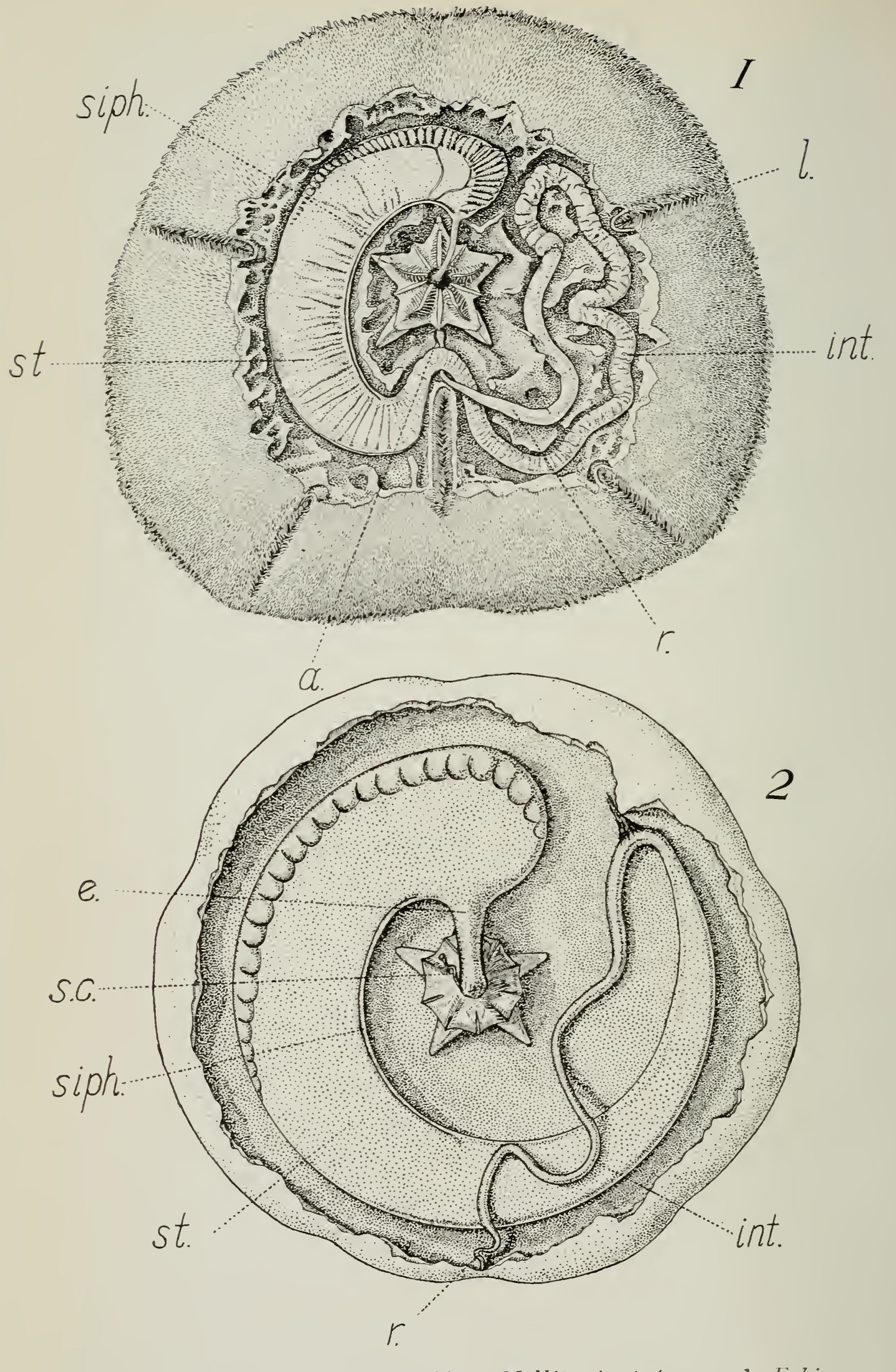
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PLATE XXIV. Anatomy of Disk-urchins, *Mellita pentapora* and *Echinarachnius parma.*

The reproductive organs are likewise modified, for the presence of the anus in the posterior interradius prevents the development of the gonad which in the regular urchins occupies this position. There are thus only two pairs of gonads developed in the adult with four symmetrical openings on the plates at the apical pole of the test, as shown in Fig. 14.

In the key-hole urchin the mouth lies near the center of the oral surface, as in the sea-urchin and sand-dollar, but the position of the anus is different from that which is found in any other echinoderm of the region, being likewise situated on the oral surface, and only a short distance posterior to the mouth (Plate XXIV, fig. 1).

The mouth is provided with five massive jaws, each ending in a sharply pointed tooth. The esophagus (Plate XXIV, fig. 1) leads towards the aboral surface, and then bends sharply anteriorly until it reaches the circle of supporting plates which surround the jaws. It then divides, as in *Arbacia,* into two branches, one of which forms the broad, flat stomach, while the other, which is closely attached to the inner margin of the stomach, is known as the siphon. The stomach (*st*) is just broad enough to occupy all the space between the inner circle of supporting plates and the outer system of plates which pass between the oral and aboral surfaces of the body.

The outer margin of the stomach is, as in *Arbacia,* provided with numerous sac-like lobes which greatly increase the secretory surface.

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EXPLANATION OF PLATE XXIV. Anatomy of Disk-urchins, *Mellita* and *Echinarachnius.*

Fig. 1. *Mellita pentapora.* Dissection of body to show alimentory canal. The slender esophagus leads from the centrally placed mouth (surrounded by five large jaws) to the broad stomach (*st*) and siphon (*siph*). The convoluted intestine (*int*), follows the definite course indicated, and passes gradually into the rectum (*r*), which opens through the anus (*a*) situated between the mouth and the median lunule. In some specimens the anus is placed at the inner end of the lunule. The five lunules (*l*) are shown.

Fig. 2. *Echinarachnius parma.* Dissection of the body to show alimentary canal; *e,* esophagus; *st,* stomach; *siph,* siphon; *int,* intestine; *r,* retum, opening on oral surface near margin of disk; *s. c,* madreporic canal. The five angular jaws are situated symmetrically about the mouth.

The stomach completes a half-circle of the body cavity in the left-handed direction, as seen from the aboral side, and is then joined by the narrow siphon mentioned above. At this point the intestine begins, and this organ bends sharply towards the mouth in order to pass between the jaws and the posterior lunule.

In the right half of the body the intestine bends sharply posteriorly beside the posterior lunule and runs in a series of broad loops nearly half-way around the body or nearly to the middle line anteriorly. It then bends sharply back on itself, occupying a position between the inner and middle series of supporting plates, and returns to the middle line between the mouth and the posterior lunule. On reaching a position near the middle line, the intestine changes into a narrow tube, the rectum (Plate XXIV, fig. 1, *r*), which crosses the first portion of the intestine on the aboral side, and then bends sharply to open to the exterior between the anterior border of the posterior lunule and the mouth.

The siphon referred to above as lying along the inner border of the stomach, is a narrow tube which makes a short passage between the two ends of that organ. By means of this siphon water can be taken in at the mouth and passed back directly to the intestine without interfering with the digestive juices of the stomach. The water thus introduced is said to serve a respiratory function in furnishing a supply of oxygen to the viscera.

In both the key-hole urchin and the sand-dollar, the posterior portion of the stomach and the whole of the intestine are commonly filled with a mass of fine sand and mud, abounding in diatom shells. This is sufficient indication that the food of these animals consists largely of such microscopic particles of organic matter as occur in the mud or adhering to the grains of sand. These particles doubtless include many kinds of living and dead organisms among which diatoms and other minute algæ are abundant.

If a fresh or well preserved sand-dollar be opened by carefully breaking away the plates of the aboral surface the internal organs are easily studied. The four brownish purple ovaries or spermaries are attached to the aboral plates. After these are removed the alimentary canal lies freely exposed.

The digestive system of the sand-dollar (Plate XXIV, fig. 2) is essentially similar to that described for the key-hole urchin, with the exception that the rectum opens to the exterior near the edge of the disk, and is on that account longer than in the latter species.

The short esophagus leads from the large jaws surrounding the mouth to the broad flat stomach. In life the stomach is green in color, with a smooth inner border (Plate XXIV, fig. 2), while its outer border is provided with many lobes of brownish color. A narrow siphon extends along the inner border, as in the key-hole urchin. The intestine nearly completes the wide circle, of which the stomach forms a part, and then bends sharply on itself to pass posteriorly, with many short bends, to the opening near the edge of the disk. The opening is sometimes almost exactly on the margin, but is more often placed near the edge of the oral surface. In young individuals it is on the aboral surface.

## HABITS

The four species of Echinoids which are found in Connecticut waters exhibit much diversity of habit, associated with differentiations of structure. The two species belonging to the order Regularia — the purple sea-urchin and green sea-urchin — are provided with large spines for protection and locomotion, and live free upon the surface of rocks, sand, shells, and other objects found upon the bottom of the sea. Between tides they often inhabit the tide pools in the rocks, hiding away in crevices and beneath seaweeds, often clinging to the frond of the seaweed itself and sometimes drawing it over the body as a protective covering. The two species of clypeastroids — the sand-dollar and the key-hole urchin,— on the other hand, are covered everywhere with extremely minute spines, and they live partly buried beneath the surface of the sand.

**Locomotion.**— The regular sea-urchins move about from place to place both by the movements of the spines and by the action of the very long tube-feet. Both sets of organs commonly assist in the process. Certain species make the greatest use of the spines in locomotion, while the tube-feet of other forms are the most efficient. In exceptional cases the former are said to be able to move rapidly without making any use of the tube-feet, and the latter to walk with the tube-feet exclusively without touching the spines to the object on which they are moving. The sand-dollar and key-hole urchin move through the sand by the actions both of the minute spines and of vast numbers of sucking tube-feet on both upper and lower surfaces of the disk-like body. These hundreds of tube-feet attach themselves to the particles of sand, and by their combined action draw the body forward, the minute spines aiding in the process.

The regular urchins can easily right themselves from any position in the water by the combined action of tube-feet and spines. The disk-urchins, on the other hand, can only right themselves after they have buried their bodies in the sand.

Locomotion in any direction is accomplished with equal ease by the regular urchins, while the disk urchins ordinarily move with the portion of the disk which bears the intestinal opening backward.

The behavior of various species of echinoids under a great variety of conditions has been studied extensively by numerous investigators. In the popular book by Romanes,* and in a recent book by Von Uexküll,† may be found most interesting accounts of the performances of these fascinating creatures.

The bodies of all species must be kept clean, and for this purpose special provision is made. In both the green and the purple urchin the intestinal opening is in the center of the upper surface. Consequently when the refuse matter is discharged it tends to fall directly upon the surface of the body. In the green urchin this region is thickly studded with minute movable spines and pedicellariæ which can be moved in such a way as to pass any foreign particles from one to the next nearer the border of the test, so that such particles are quickly cast away from the body. The tube-feet also aid in the cleaning process.

Elizabeth and Alexander Agassiz‡ describe this action of the pedicellariæ in the following words: — "If we watch the sea-urchin after he has been feeding, we shall learn at least one of the offices which this singular organ performs in the general economy of the animal. That part of his food which he ejects passes out at an opening on the summit of the body, in the small area where all the zones converge. The rejected particle is received on one of these little forks, which closes upon it like a forceps, and it is passed on from one to the other, down the side of the body, till it is dropped off into the water. Nothing is more curious and entertaining than to watch the neatness and accuracy with which this process is performed. One may see the rejected bits of food passing rapidly along the lines upon which these pedicellariæ occur in greatest number, as if they were so many little roads for conveying away of the refuse matters; nor do the forks cease from their labor till the surface of the animal is completely clean, and free from any foreign substance. Were it not for this apparatus the food thus rejected would be entangled among the tentacles and spines, and be stranded there till the motion of the water washed it away."

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* Jellyfish, Starfish, and Sea-Urchins.

† Umwelt und Innenwelt der Tiere.

‡ Seaside Studies in Natural History, page 105.

In the purple urchin the aboral area is devoid of spines, and so smooth that refuse matter or foreign particles which fall upon it will be easily washed away by currents of water or by the movements of the animal.

In the disk-urchins the intestinal opening is placed at the edge of the disk or on the lower surface, so that the fecal matter does not fall upon the body. Furthermore the spines are covered with cilia, and these create a current of clean water which constantly flows past the animal and washes away any very minute foreign particles. The movements of the minute spines and tube-feet brush away any particles which are not thus removed.

**Food.**— The regular urchins feed largely upon seaweeds, but also devour any dead animal matter obtainable and supplement their diet by the diatoms and such other minute organisms as are found upon the bottom on which the animals live. Much sand and mud is swallowed for the organic matter in it. The disk-urchins swallow great quantities of sand, with such diatoms and other minute organisms as it contains.

**Natural enemies.**— Many kinds of fishes feed upon all our species of echinoids, in spite of their covering of spines, and the free-swimming embryos are subject to the attacks of still other species of fishes.

## REPRODUCTION

In the class Echinoidea there are no species which are capable of asexual reproduction, such as occurs in some of the Asteroidea, the production of eggs which require fertilization being the only means of reproduction in this class.

The echinoids are of separate sexes, although it is impossible to distinguish the males from the females externally. Each female discharges vast numbers of eggs into the water during the breeding season of each year of her life. In one of the foreign species a large female may produce twenty million eggs yearly. Owing to the gregarious habits of the animals, the eggs stand a reasonable chance of being fertilized by the sperm cells which are discharged in enormous numbers by the male urchins at the same season.

It often happens, as is also the case with the starfish, that certain animals fail to mature and discharge their sexual products at the normal season, but eggs discharged at other periods of the year must almost always fail of fertilization or development.

The eggs are so numerous and easily obtained that they have become classical objects for the study of the processes of fertilization and early development. The suggestions on page 50 regarding the study of starfish eggs will be found equally appropriate for those of the urchins.

## DEVELOPMENT

As illustrated by Fig. 15, the immature eggs in the ovary of the urchin are each provided with a large germinal vesicle. After the two polar bodies are formed, the egg is discharged into the water; it then settles slowly to the bottom and is ready for fertilization. A single sperm cell, which may be swimming about in the water in the vicinity, may enter the egg. After such union the fertilized egg divides regularly into 2, 4, 8, and 16 cells, called blastomeres, as illustrated in Fig. 15.

These divisions take place very rapidly, the first cleavage occurring in about an hour and a quarter after fertilization, and succeeding cleavages at intervals of an hour or less.

A hollow sphere of cells known as the blastula is then formed. In about twelve hours after fertilization the blastula becomes

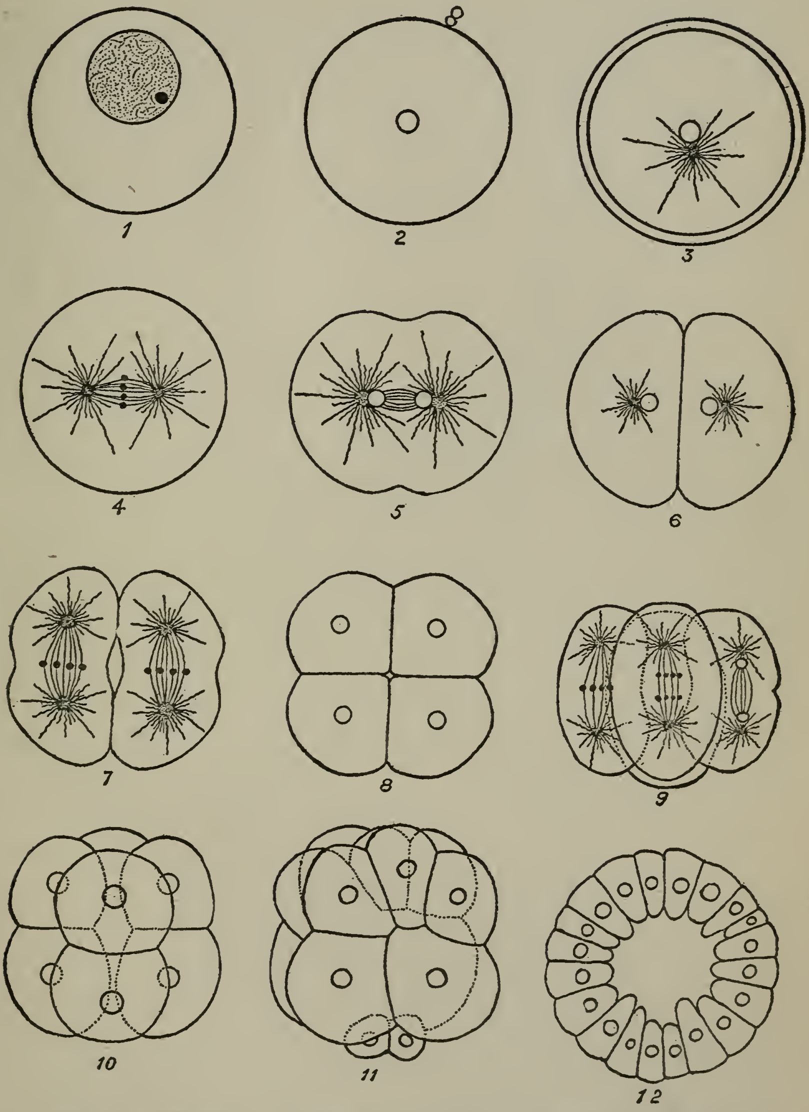

FIG. 15. Cleavage of egg of Sea-urchin. 1, egg from ovary; 2, mature egg with the two minute polar bodies; 3, fertilization; 4 to 6, first cleavage, forming two blastomeres; 7, 8, second cleavage, with 4 blastomeres; 9, 10, third cleavage, with 8 blastomeres; 11, fourth cleavage, with 16 blastomeres; 12, section of blastula. The blastula soon becomes covered with cilia and swims actively about in the water. (After Wilson.)

covered with vibrating cilia, and the embryo swims round and round within the egg membrane. This membrane soon bursts, and the free-swimming blastula rises from the sea bottom to swim at the surface of the water.

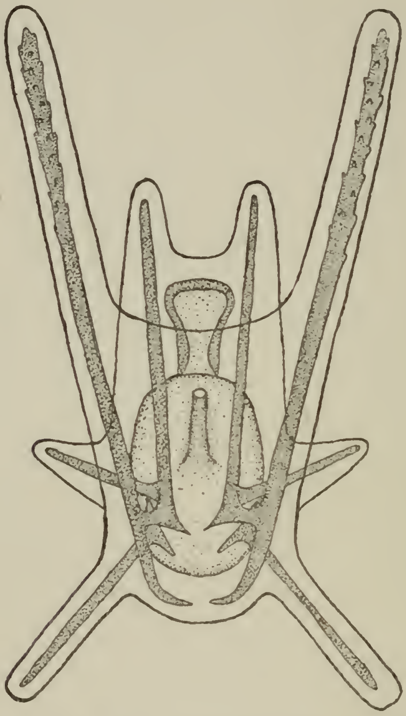

Fig. 16. Free-swimming larva (pluteus) of the purple sea-urchin, *Arbacia punctulata*. The deeply shaded portions represent the calcareous skeletal rods in the four pairs of arms. The primitive mouth, stomach, and intestine occupy the central portions of the body. (After Weysse.)

After an infolding of the cells on one side to form a mouth and a primitive alimentary canal, a complicated series of changes in the embryo occurs. It finally assumes the shape of a helmet, with long projecting arms, and bands of very long cilia. It now swims freely about, usually in company with millions of others, and begins to feed upon the minute organisms living at the surface of the sea. The embryo, or larva, is now bilaterally symmetrical, with both mouth and anus, and is known as a *pluteus* (Fig. 16). It bears absolutely no resemblance to the adult urchin. The free-swimming pluteus lives and feeds at the surface for a period of several weeks, the time depending somewhat on the temperature and other conditions, and varying in different species. In this time it may have been carried by currents and tides to a considerable distance from its place of origin.

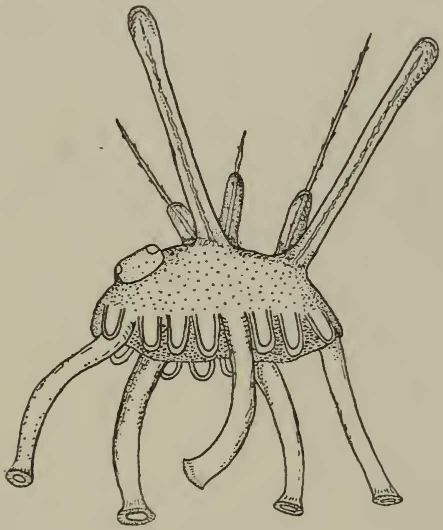

FIG. 17. *Arbacia punctulata.* Side view of young urchin immediately after the metamorphosis. The spines remaining from the pluteus are in process of absorption. (After Brooks.)

When ready to assume the adult form, the pluteus settles to the bottom, absorbs its larval organs, and by a complicated metamorphosis assumes the condition of a young urchin (Figs. 17 and 18). The young urchin differs from the adult in having the whole upper surface covered by the plates which will eventually form only the periproct of the adult, and by the relatively enormous tube-feet. The animal is now radially symmetrical, and creeps about on the sea bottom after the manner of the adult urchin. It feeds upon diatoms and other minute organisms until, by its further growth, and the development of plates and spines, it is able to assume the habits of the adult.

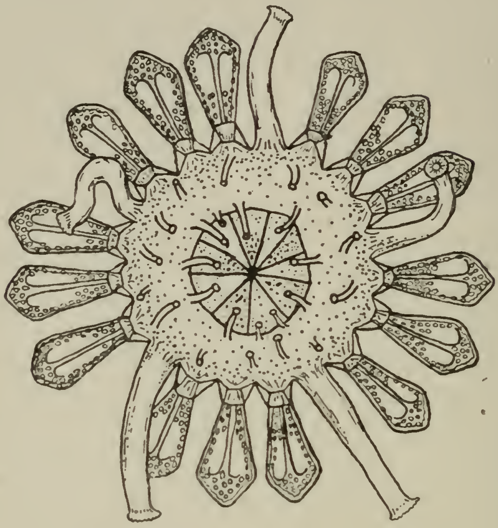

FIG. 18. *Arbacia punctulata.* Oral surface of young urchin shortly after the metamorphosis. (After Brooks.)

The **clypeastroids** pass through stages very similar to those of the regular sea-urchins. The sand-dollar, for example, develops from a long-armed pluteus, which settles to the sand at the sea bottom and gives rise to the young sand-dollar. This has at first a few relatively long spines and large tube-feet. There is now a nearly complete radial symmetry, the intestinal opening at this stage being near the center of the upper surface, somewhat as in the regular urchins. With the further growth of the animal, its bilateral symmetry becomes more marked, and the anus is gradually shifted to its final position near or beneath the edge of the disk.

Grave* has been successful in rearing large numbers of the key-hole urchin from the fertilized eggs, and following their transformations to the adult form. The egg of this species likewise develops into a long-armed pluteus, and this by a complicated metamorphosis gives rise to the bizarre creature shown in Fig. 19, which actually represents the young urchin, although it differs widely in appearance from the adult. The oval body is provided with a small number of spines and tube-feet of relatively

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* C. Grave. *Biol. Bulletin*, vol. v, 1903.

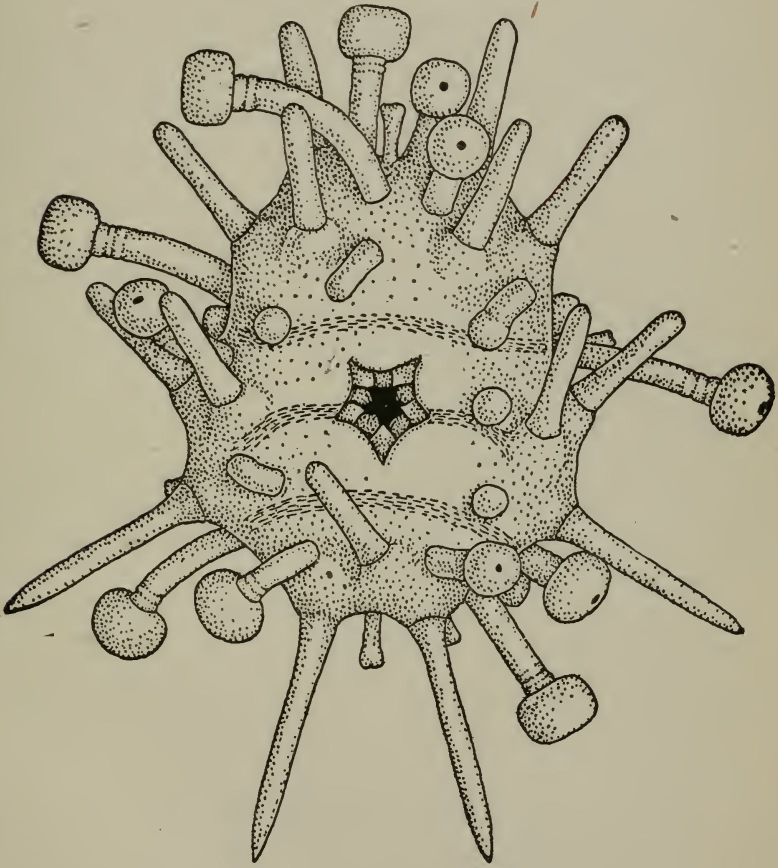

FIG. 19. *Mellita pentapora.* Young urchin shortly after the metamorphosis from the free-swimming pluteus. The pentagonal area in the center represents the mouth, in the angles of which are the five teeth. The spines and tube-feet are at this stage of enormous size relative to the size of the body. (After Grave.)

enormous size. By means of the tube-feet the creature clings to the objects on which it rests and crawls slowly about. In the center of the body is the pentagonal mouth with the five calcareous teeth, and extending across the body are three bands of cilia which are thought to serve in sweeping towards the mouth the small particles of organic matter on which the animal feeds. With the increase in size of the body the ciliated bands disappear, and the now relatively minute tube-feet convey the food to the mouth. As the disk-like body of the animal increases further in size, the anal opening, which is at first on the aboral surface, is gradually shifted to the edge of the disk. The enlargement of the disk now becomes interrupted at certain points on the periphery, causing five notches in the margin. By continued growth of the intervening portions the notches become elongated, and their edges close together and unite distally, to form the characteristic lunules.

## KEY TO SPECIES

The echinoids of the world are divided into three orders: (1) **Regularia**, including the hemispherical sea-urchins; (2) **Clypeastroidea**, including the flat and disk-like forms; and (3) **Spatangoidea**, or heart-urchins.

The two first orders only are found in Connecticut waters, and of these there are four representatives; two, the purple sea-urchin and the green sea-urchin, belonging to the Regularia, and two, the sand-dollar and the key-hole urchin, to the Clypeastroidea. They may be easily distinguished by the following characters:—

1. Body nearly hemispherical, spines rather large, anal opening at aboral pole ....................................2
   Body flat and disk-shaped, spines small, anal opening eccentric ....................................3
2. Spines long, absent near aboral pole...**Arbacia punctulata**
   Spines short, covering aboral pole........................ **Strongylocentrotus dröbachiensis**
3. Test without perforations..........**Echinarachnius parma**
   Test with five narrow perforations (lunules)............. **Mellita pentapora**

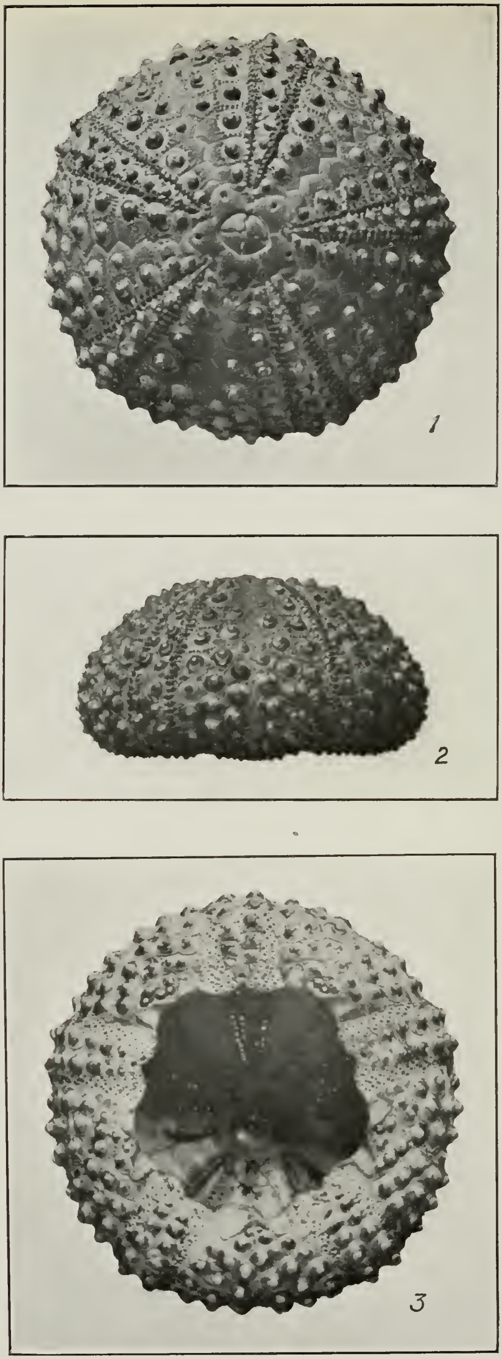

PLATE XXV. Purple Sea-urchin, *Arbacia punctulata*. Tests with spines removed. (Natural size.) After Clark.

### **Arbacia punctulata** (Lamarck)

### Purple Sea-urchin

Plates XX, XXII, XXV.

This is the only species of the regular sea-urchins common in the greater part of Long Island Sound. It is widely distributed, but occurs in abundance only in restricted localities. It prefers shelly or rocky bottoms, and is often dredged from the oyster beds. It sometimes occurs between tides in the tide pools in rocky places, hiding in crevices or beneath seaweeds.

The species occurs in shallow water along the coast from Cape Cod to the Gulf of Mexico. There is great variation in the abundance of individuals of this species in the same locality in different years. At the Biological Laboratories at Woods Hole, Mass., large numbers of these urchins are desired for embryological and experimental studies each year, and, while in some years the species can be found in unlimited numbers, in other years it is extremely difficult to secure a supply. On the oyster beds off New Haven Harbor, there seems to be a similar variation in numbers.

The purple sea-urchin is commonly from one to two inches in diameter, excluding the spines. The spines are heavy and solid, and measure from one-half to one inch in length. Each is fluted longitudinally, and, while some of the upper ones are acutely pointed, others are blunt. Towards the oral surface they become shorter and flattened at the tip. They are usually of a purplish color. The test is likewise reddish, purple, or purplish brown, while the tube-feet are red or brown.

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Explanation of Plate XXV. Purple Sea-urchin, *Arbacia punctulata.* (Natural size.)

Fig. 1. Aboral surface of test with spines removed, showing arrangement of plates. The five double rows of dotted plates represent the ambulacral areas, while the intervening rows of plates comprise the interambulacral areas. The four plates at the center form the periproct. Each of the interambulacral areas ends in a plate with a small perforation, the genital pore. One of these plates is somewhat larger than the others and serves as the madreporic plate.

Fig. 2. Side view of test.

Fig. 3. Oral surface of test, showing the large opening covered in life by the peristome.

(From photographs loaned by the U. S. Fish Commission, with permission of Dr. H. L. Clark.)

The aboral pole is free from spines for a considerable distance; not only are the plates of the periproct and the genital plates naked, but spines are likewise absent from the middle of the interambulacral areas for a distance nearly half-way to the equator of the test. Only the large primary spines are present. They are arranged in a double series in each ambulacral area, and in four to eight or more series in each interambulacral area. There are five pairs of prominent buccal plates.

In Connecticut waters the sexual products are matured in early summer. The eggs contain particles of the purplish pigment which permeates nearly all the tissues of the body. They are admirable objects for the study of the processes of fertilization, cleavage, and early embryonic development.

For such a study the suggestions given for the examination of the starfish egg will apply equally well. The free-swimming embryo, known as the pluteus, may be kept alive for a number of days, but nearly all attempts to rear artificially to the adult form have failed.

### **Strongylocentrotus dröbachiensis** (O. F. Müller)

Green Sea-urchin

Plates XXI, XXVI.

This is a typical circumpolar species, occurring in great abundance north of Cape Cod, and is found but locally in Connecticut waters. It extends southward in the deep water off our coast as far as New Jersey, but south of Cape Cod it is of much smaller size than northward.

In Long Island Sound small specimens have been dredged off New Haven and Stratford; but these individuals or their ancestors have presumably been carried in their early stages by the

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Explanation of Plate XXVI. Green Sea-urchin, *Strongylocentrotus dröbachiensis.* (Natural size.)

The upper figure shows the aboral surface, thickly covered with the primary and secondary spines.

In the center of the aboral surface (lower figure) is seen the peristome with the five sharp white teeth which close the mouth. Between the spines are shown the five double rows of slender tube-feet with enlarged terminal sucking disks.

(Photographs loaned by the U. S. Fish Commission, with permission of Dr. H. L. Clark.)

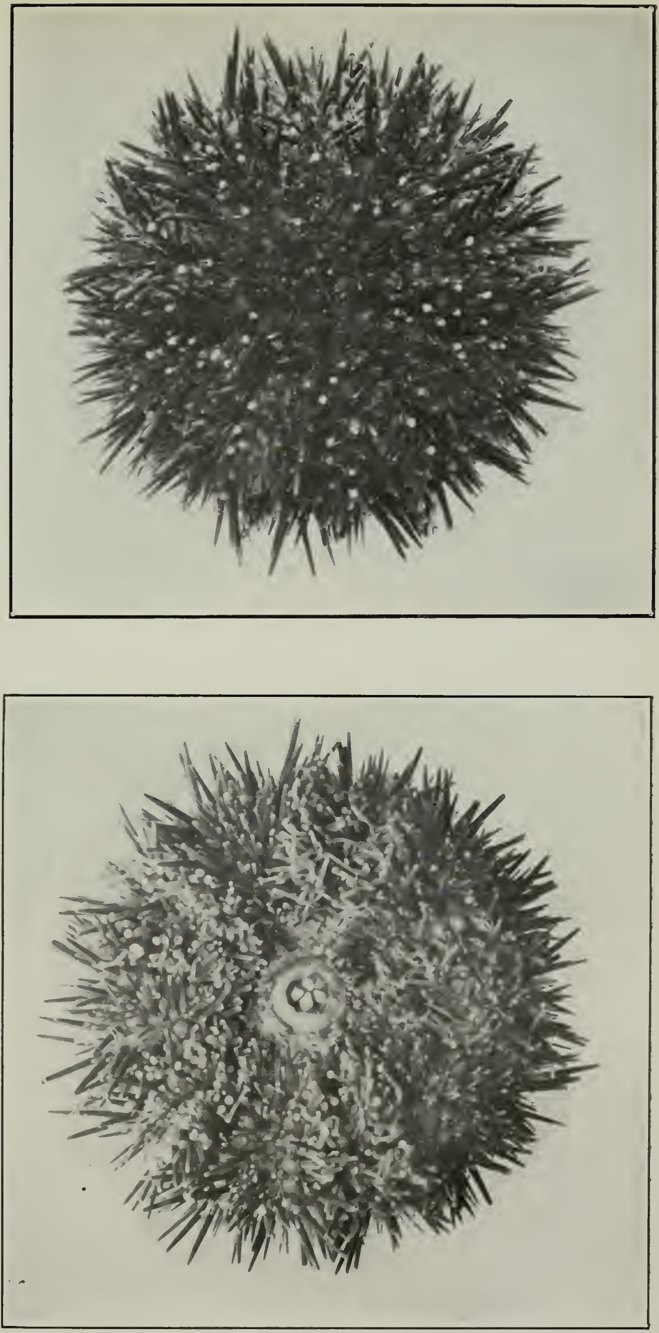

PLATE XXVI. Green Sea-urchin, *Strongylocentrotus dröbachiensis.* (Natural size.)

westward currents from the colder and deeper waters nearer the eastern portion of the Sound. Specimens have been taken near the Thimble Islands and near Faulkner's Island. Off New London and eastward to Watch Hill, Rhode Island, the individuals become increasingly abundant and of larger size. The species also occurs on the northern coasts of Europe, the north coast of Siberia, and on both sides of the northern Pacific Ocean and Bering Sea, southward to Kamchatka on the west and Puget Sound on the east.

The species prefers rocky bottoms, the food consisting largely of algæ growing upon the rocks. Mud containing diatoms and other minute organisms is swallowed in abundance, and any dead animal is greedily devoured. Even the bones of a dead fish will be cut away with the sharp teeth and completely devoured.

Farther to the north the species lives in great abundance between tides. In the southern part of its range it may reach a depth of more than 600 fathoms.

Individuals of this species grow to a larger size than do those of the purple urchin, the diameter of the test measuring from two to three inches in large specimens.* The test is rather flattened, being about half as high as broad. The spines are exceedingly numerous, but are small and short, the largest being only about a half-inch in length.

The peristome measures from three-fourths to one inch in diameter, and is proportionally larger in young than in mature individuals. The anal plates are numerous and very small in full-grown specimens.

The color in life is greenish, varying in shade in different individuals and often on different parts of the body. Many specimens have the zones bearing the tube-feet much lighter in shade than the interambulacral areas. In many there is a yellow, red, or purple tinge, due to variations in the coloration of the spines; and in some these shades are intensified, the spines being tipped with deep red, purple, or violet. The miliary spines, pedicellariæ, and tube-feet are whitish or pale violet.

The species differs from *Arbacia punctulata* in that all the plates of the aboral pole bear minute protective spines. The larger spines of the test are longitudinally fluted and pointed at the tip. They are arranged in a double series on each ambulacral and interambulacral area. Scattered thickly among the primary spines are much smaller, secondary, spines of similar shape, while a third variety, the miliary spines, are still smaller and very slender. There are five pairs of buccal plates, which bear miliary spines. The comparative sizes of the spines and their arrangement are well shown by the tubercles on the test (Plate XXI).

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* Several very large specimens in the Yale University Museum exceed four inches in diameter.

Several kinds of large fishes, including the wolf-fish, swallow the adult animals whole, quite disregarding the sharp spines which cover the body. The young have still more numerous enemies among the fishes, and the free-swimming plutei are swallowed in great numbers by surface-feeding fishes.

### Echinarachnius parma (Lamarck)

Sand-dollar

Plate XXIII; Plate XXIV, fig. 2; Plate XXVII.

The sand-dollar is a most interesting little creature because of its peculiar modifications to meet the requirements of the environment under which it lives. It is sometimes very abundant on sandy bottoms off shore, where it lives partly buried beneath the surface of the loose sand. The body is covered with a multitude of tiny suckers, by means of which the creature creeps slowly along, devouring as it goes particles of sand with the numerous microscopic organisms, particularly diatoms and other algæ, which are found among them.

The much flattened, disk-like body is well adapted for withstanding any tendency to be rolled over or thrown upside down by the shifting of the sand under the influence of the waves. It is very probable, moreover, that the animal can penetrate deeper into the sand when the water becomes very rough, to return to the surface again after the disturbance is over.

The species has a remarkable range of distribution. It is found along the Atlantic coast from Labrador to New Jersey, and

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EXPLANATION OF PLATE XXVII. *Echinarachnius parma.* Aboral and oral surfaces. (Natural size.)

The aboral surface, upper figure, shows the minute spines and the darker ambulacral areas, "petals". The oral surface, lower figure, shows the ambulacral areas as narrow furrows radiating from the centrally placed mouth and branching on each side toward the margin. These areas are nearly devoid of spines. A cluster of less slender spines surrounds the mouth.

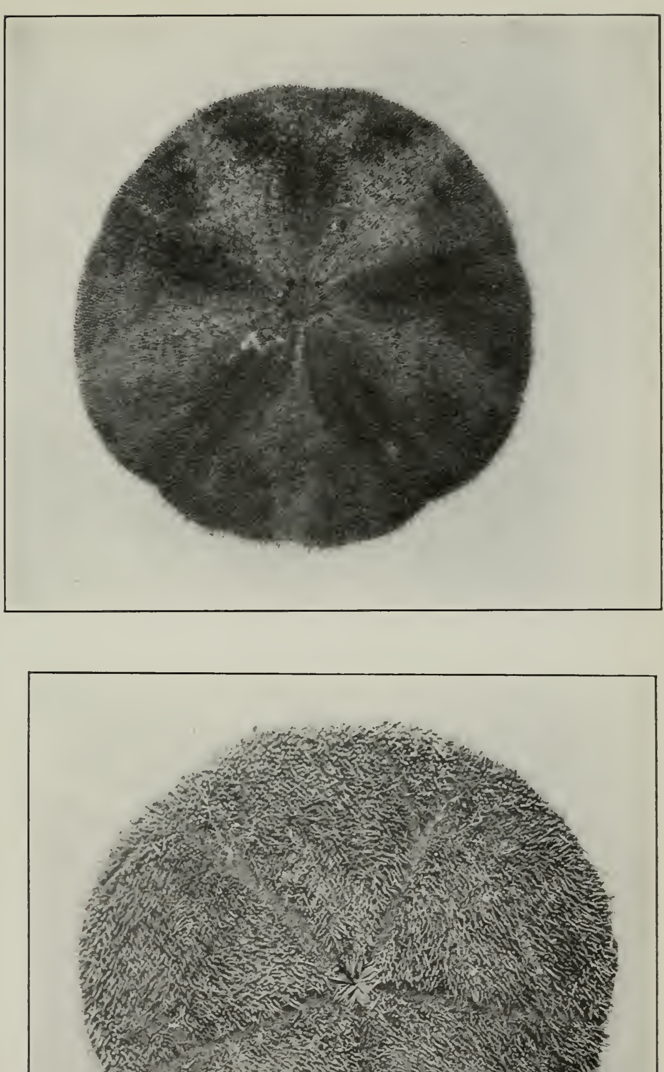

PLATE XXVII. Sand-dollar, *Echinarachnius parma*. Aboral and oral surfaces. (Natural size.)

on both sides of the Pacific Ocean, extending from the Aleutian Islands along the American shore as far south as British Columbia and on the Asiatic shore southward to Japan. In the more northern parts of its wide range it is found near low-water mark, but farther south it occurs only in deeper water. It has been collected from a depth of more than eight hundred fathoms.

The color of the body in life is usually purplish brown or reddish brown, some specimens inclining to purple while others are distinctly red. When young, a paler red color predominates. Many individuals have the ambulacral areas darker red than the remainder of the body. In alcohol, the color changes to a dark green or brown, and the alcohol dissolves so much of the pigment as to become deeply colored. Dried specimens are likewise dark green or brown. Verrill states that the fishermen sometimes made an indelible marking ink by grinding up the skins and spines of these animals and mixing with water.

The body is nearly circular in outline, but is indented at one point, which indicates the position of the anus. The surface of the body is everywhere thickly covered with minute spines (Plate XXVII), so delicate and closely placed as to form a velvety covering.

On the aboral surface the ambulacral areas are plainly marked by the position of the respiratory tube-feet. These areas are symmetrically placed about the central plate, and constitute the so-called petals.

In the test after the removal of the spines (Fig. 14), the position of the petals is clearly shown as forming the aboral ends of the ambulacral areas (*amb*). The interambulacral areas likewise bear tube-feet, but they are here much smaller than those of the petals. At the tips of the ambulacral areas the position of the terminal tentacle is indicated, and between them the four openings of the genital glands.

On the oral surface the ambulacral areas are marked by furrows (Plate XXVII). The peristome is very small (Plate XXIII), although the five calcareous teeth are well developed and very sharp.

In many localities the species is so abundant as to form an important part of the food supply of certain fishes, particularly of the flounder, codfish, and tautog.

### **Mellita pentapora** (Gmelin)

Key-hole Urchin

Plate XXIV, fig. 1; Plate XXVIII.

The name *Mellita testudinata* was given to this species by Klein in 1734; but, as this long preceded the Linnæan code, the specific name *pentapora* proposed by Gmelin in 1788 should be adopted. Many authorities, however, insist upon the use of *testudinata*.*

This species has a flat test, and in this respect bears a superficial resemblance to the common sand-dollar, but is easily distinguished by the five narrow openings, termed lunules, which pass completely through the body as shown on Plate XXVIII. One of these lunules is situated in the posterior interradius, about half-way from center to circumference, while the other four are symmetrically placed, one in the center of each radius except the anterior.

The flattened test is densely covered with short but slender spines of a brownish color. The general color of the living animal is commonly pale brown, sometimes with a tinge of green.

Especially after the spines are removed, the petaloid ambulacral areas are conspicuous on the aboral surface. On the oral surface the narrow ambulacral furrows are provided with paired branches which extend peripherally from the mouth to the edge of the disk. Each of the main branches has lateral offshoots (Plate XXVIII).

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* In a recent paper (*Annals and Mag. Nat. Hist.*, 8 ser., vol. vii, 1911) Clark recommends the adoption of the name *quinquiesperforata* Leske for this species.

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Explanation of Plate XXVIII. Key-hole Urchin, *Mellita pentapora*. (Natural size.)

Aboral and oral surfaces of two dried specimens. The minute spines have been removed from the left-hand side of each. The aboral surface shows three of the five ambulacral areas, "petals". The mouth lies in the center of the oral surface, with the anus near the inner end of the median lunule. One of the posterior lunules in the lower figure is abnormal in that it remains open to the edge of the disk.

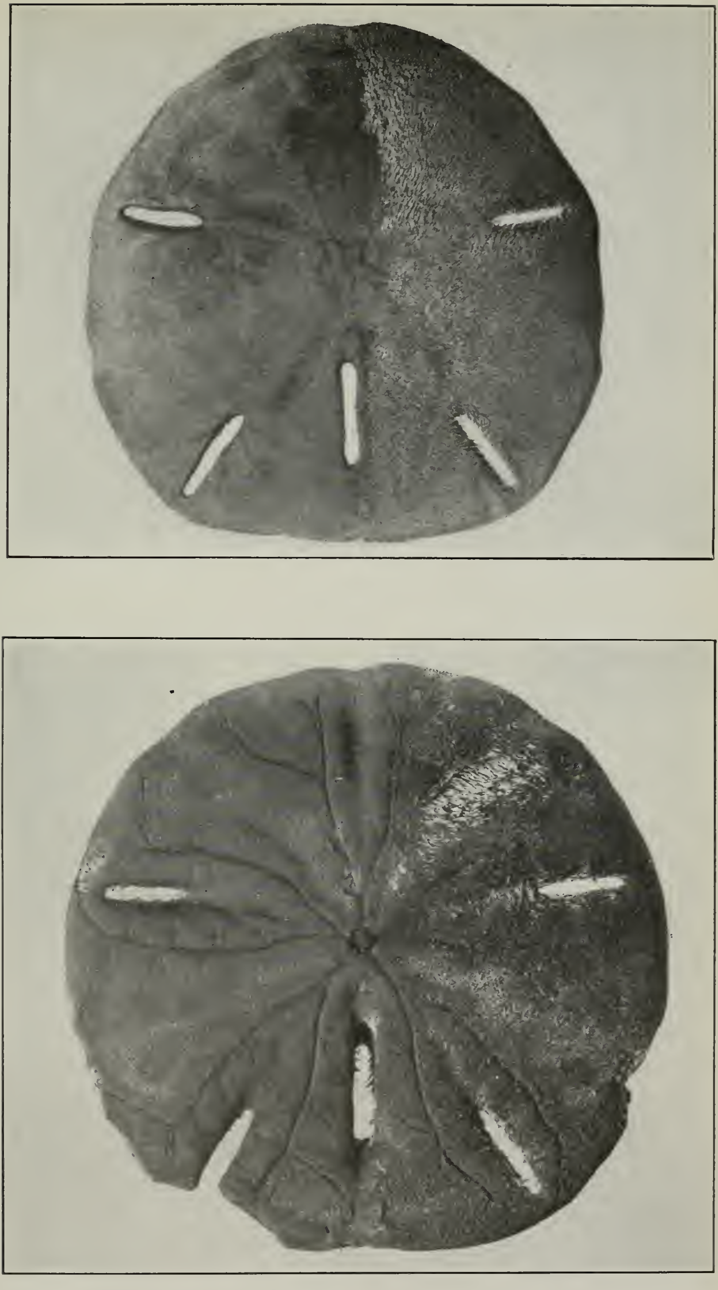

PLATE XXVIII. Key-hole Urchin, *Mellita pentapora*. (Natural size.)

The mouth is situated a little anterior to the center of the oral surface, while the posterior opening of the intestine lies between the central end of the interradial lunule and the mouth.

In some specimens one or more of the lunules, as shown on Plate XXVIII, may extend quite to the margin of the disk. Such an abnormality may be caused either by accidental injury or by the failure of the two edges of the lunule to unite together distally in the young urchin.

This species occurs locally from Nantucket to Brazil in shallow water, although it is not common north of Cape Hatteras. In Long Island Sound the species has been collected at Huntington, Long Island, a number of specimens from this locality belonging to the Yale University Museum.

A description of the digestive system of this species may be found on page 95, while Plate XXIV, fig. 1, illustrates the internal anatomy.

In a paper by Grave* the structure and development of the larvæ have been described and illustrated.

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* *Johns Hopkins Univ. Circular,* No. 157, 1902.

## CLASS IV. HOLOTHUROIDEA

The animals included in this class are sometimes called sea-cucumbers. They are, however, not so well known to people other than naturalists as are the other classes, and most of them can hardly be said to have any English names.

The six species of holothurians found along the Connecticut coast or in reasonable proximity thereto are all limited to certain restricted localities, and their presence in any particular spot cannot be predicted with any considerable degree of certainty. In general, a muddy bottom below low-water mark is favorable for the large, brown or blackish *Thyone briareus,* while the others prefer sandy localities, the two species of *Synapta* occurring frequently between tides, and the *Cucumaria* only below the ordinary tides. The two other species, *Thyone unisemita* and *Thyone scabra,* have not yet been recorded from Connecticut waters, but their presence in Narragansett Bay and near the eastern end of Long Island Sound makes it probable that they actually occur within the limits of the Sound, and that future investigations will reveal their presence in these waters.

### STRUCTURE

These animals have but little superficial resemblance to the other classes of Echinoderms, although in their general anatomical structure they show their relationship. In contrast with the

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EXPLANATION OF PLATE XXIX.

Fig. 1. *Synapta roseola.* Five times natural size. The two longitudinal lines represent two of the five bands of longitudinal muscles.

Fig. 2. Tentacle of same species, with seven digits. Much enlarged.

Fig. 3. *Synapta inhærens,* with the twelve tentacles surrounding the widely opened mouth. The body is strongly contracted and shows the constrictions due to action of the circular muscles. Along the axis of the body one of the bands of longitudinal muscles is shown. Five times natural size.

Fig. 4. Tentacle of same species, with nine digits. Much enlarged.

Fig. 5. *Thyone briareus.* Two-thirds natural size. The dorsal surface is toward the top of the page, the lower, rounded margin being in the mid-ventral line.

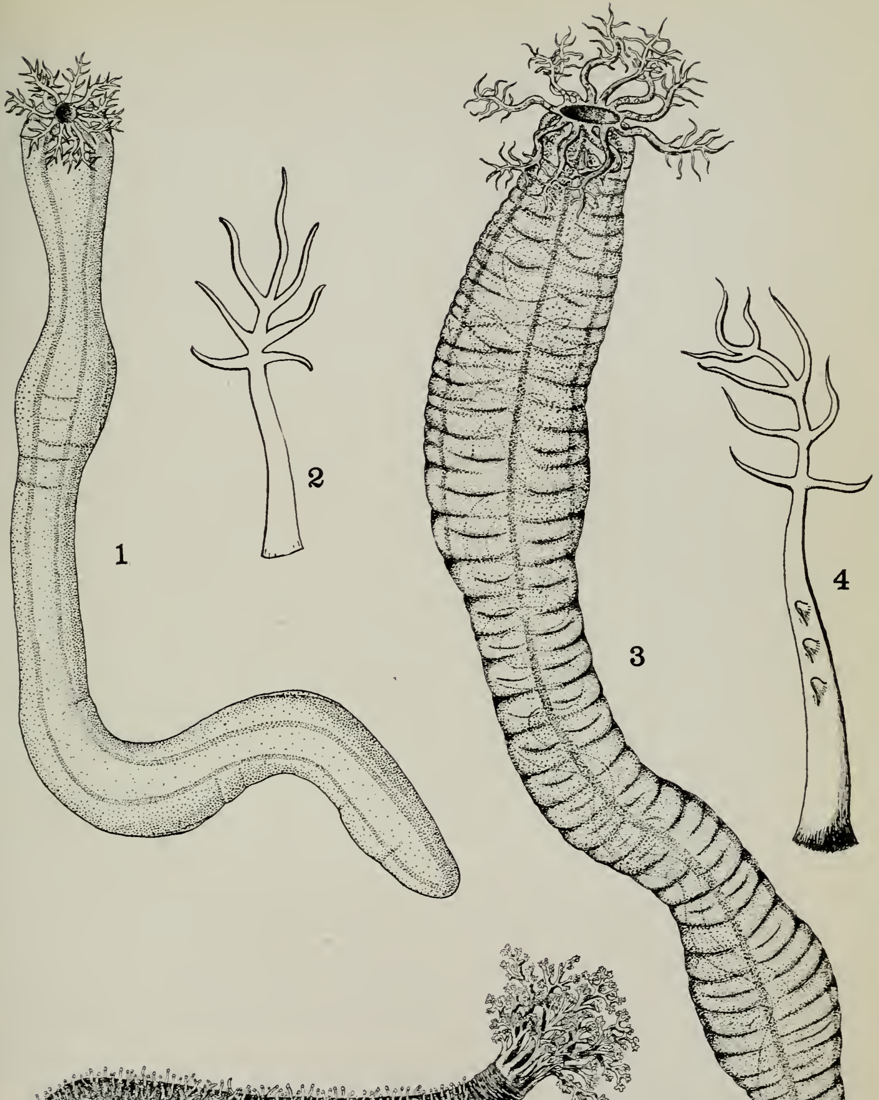

PLATE XXIX. Holothurians.

hard, spiny body coverings possessed by the starfish, brittle stars, and sea-urchins, the holothurians have soft, sac-like or worm-like bodies (Plates XXIX, XXXI, XXXII), in the skin of which only very small calcareous plates are found. The mouth, at one end of the elongated body, is surrounded by a circle of branched oral tentacles comparable with the oral tube-feet or tentacles of the other Echinoderms. The intestine ends in a sac-like cloaca at the end of the body opposite the mouth.

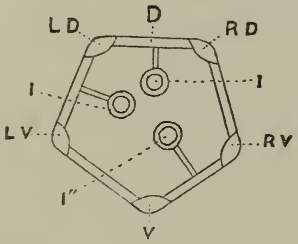

FIG. 20. Diagram of transverse section of the body of a holothurian. *D,* dorsal interradius; *I, I', I'',* first, second, and third sections of intestine attached to adjacent interradii; *LD, LV, RD, RV,* and *V,* left dorsal, left ventral, right dorsal, right ventral, and ventral radii, respectively.

The body is in most species adapted for creeping upon the sea bottom; and, as the animal habitually creeps with the same side uppermost, there has come about a fairly well-marked differentiation into a ventral and a dorsal surface.

Three of the five ambulacral areas are situated upon the ventral surface, and are usually provided with more highly developed tube-feet, or pedicels, with sucking disks. The pedicels of the two dorsal ambulacral areas are commonly modified as delicate finger-like processes used for respiration and sensation. In many forms, as *Thyone* (Plate XXXI), the pedicels are scattered over the whole surface of the body, while in such burrowing forms as *Synapta* there are no pedicels whatever (Plate XXIX, figs. 1, 3).

With the habit of creeping upon the side there has also come a bilateral symmetry of the body, so that it is customary to speak of the oral and aboral ends as anterior and posterior, and the terms right and left are applied as in other bilaterally symmetrical animals.

The body walls are very muscular, with enormously powerful longitudinal muscles running the length of the body along the five radii, which correspond to the ambulacral areas of the other groups (Fig. 20). Transverse muscles serve to diminish the circumference of the body, and thus, by exerting pressure on the fluids in the body, cause the animal to elongate. The interaction of the two sets of muscles enables the creature to move in a worm-like fashion.

The general anatomical features of the holothurians may be well illustrated by a study of *Thyone,* as described below.

**Internal Anatomy of Thyone.**— Few marine invertebrates are more satisfactory for the study of internal anatomy than the common *Thyone.* For this reason the more conspicuous of its organs will be briefly described in this place, although the details of the water-vascular system, blood system, and nervous system, the description of which would require more space than is here available, must be omitted.

So powerful are the contractions of the body walls when the animals are injured, that, unless some special precautions are taken in killing the specimens for dissection, the body may be ruptured, and the whole crown of tentacles and a portion of the viscera may be ejected. A convenient method of avoiding this trouble is to seize the living holothurian immediately behind the tentacles with strong forceps and plunge it into boiling water. If the experiment is successful, the tentacles will remain partially expanded, and the body walls intact.

For a study of the internal organs, the body should be opened with scissors along the whole length of the ventral surface.

On opening the body, the viscera are found to be situated in a large central cavity, the body cavity, or cœlom. In life the space between the viscera and the body walls is filled with the cœlomic fluid.

**Alimentary canal.**— Of the ten branched tentacles which surround the mouth, two are much smaller than the others, and will serve to indicate the ventral side of the body (Plate XXX). If a slit is made through the ventral body wall throughout the

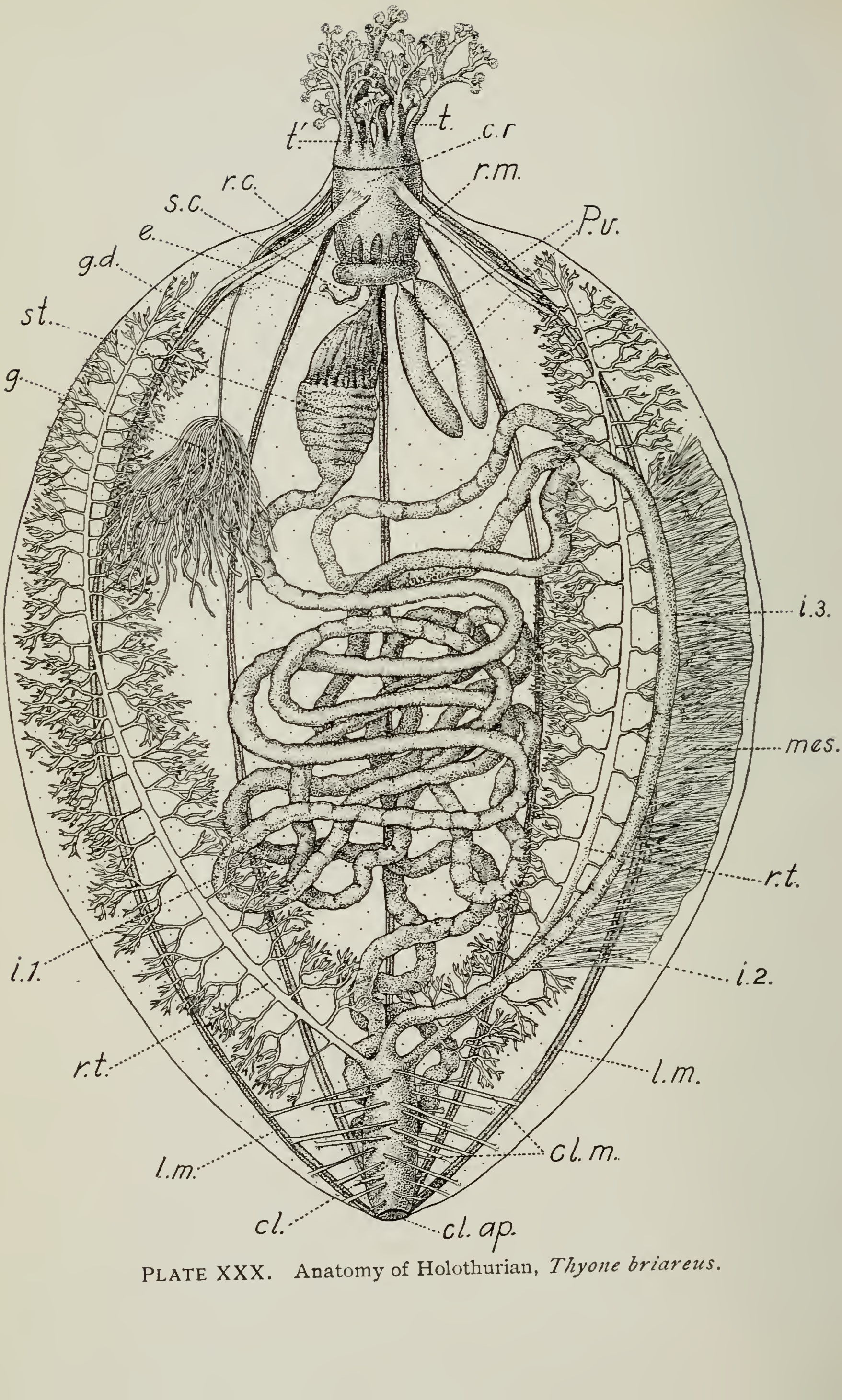
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PLATE XXX. Anatomy of Holothurian, *Thyone briareus.*

length of the body, and the cut walls folded and pinned back, the arrangement of the internal organs is plainly visible.

In the spacious body cavity lie the much coiled intestine, the profusely branched respiratory trees, the Polian vesicles, the madreporic canal, and other organs, as shown on Plate XXX.

At the anterior end of the body the slender esophagus leads from the region of the calcareous ring at the base of the tentacles back to the sac-like stomach. The walls of the stomach are highly muscular and much thicker than the other parts of the alimentary canal. At its posterior end the stomach becomes much narrowed, and leads into the long and much coiled intestine. The total length of the intestine is several times that of the body. It is arranged in three broad loops, each of which is in itself much convoluted (Plate XXX). The first section leads with many folds posteriorly (near the mid-dorsal line) to the dorsal side of the cloaca. Here there is a sharp bend with several convolutions, and the second section leads forward (on the left dorsal side) to the anterior half of the body. After several further twists back and forth through the cœlomic space, the third section leads posteriorly (on the right ventral side) to

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Explanation of Plate XXX. Anatomy of Holothurian, *Thyone briareus.* (Twice natural size.)

The body has been opened on the ventral side by a longitudinal incision extending the whole length of the animal in the right ventral interradius. The body walls and viscera are spread symmetrically on both sides. In the crown of tentacles (*t*) are seen the two smaller ventral tentacles ($t^1$). From the calcareous ring beneath the tentacles, the slender esophagus (*e*) leads into the saclike stomach (*st*), and thence into the intestine. The intestinal convolutions are not represented in exactly their natural positions, but it is possible to distinguish the three main sections (*i. 1, i. 2, and i. 3*) of this canal. The intestine is attached to the body walls by strong mesenteries, of which only one (*mes*), connected with the posterior section of the intestine, is represented. The cloaca (*cl*) is connected with the body walls by strong muscles (*cl. m*); its connection with the exterior through the cloacal aperture (*cl. ap*) is shown. From the anterior end of the cloaca the pair of profusely branched respiratory trees (*r. t*) extend nearly to the anterior end of the body cavity. The slender filaments of the sexual gland (*g*) lead to a narrow genital duct (*g. d*), which opens on the dorsal side of the body between the bases of the dorsal tentacles. The five pairs of powerful longitudinal muscles (*l. m.*), which mark the five radii of the body, connect anteriorly with the equally strong retractor muscles (*r. m*) of the peristome. At the base of the calcareous ring (*c. r*), beneath the tentacles, the ring canal (*r. c*) of the water-vascular system is seen. This canal is connected with the large saclike Polian vesicles (*P. v*), and the slender madreporic canal (*s. c*), the latter ending in a small madreporic plate.

open into the anterior end of the broad, muscular cloaca. The intestine is supported by three mesenteries, attached to the corresponding interradii. Thus the proximal section is attached along the greater part of the length of the mid-dorsal interradius, the second section to the left dorsal interradius, and the last section to the right ventral interradius, as shown in Fig. 20. In its total length the intestine describes a partial spiral turn around the main axis of the body, as is easily seen by the position of the attachment of the mesenteries.

The mesentery attaching the third section to the right ventral interradius is shown on Plate XXX.*

**Calcareous Ring.**— Surrounding the anterior end of the esophagus, and forming a support for the oral tentacles, is a broad calcareous ring, consisting of five radial and five interradial plates. The radial plates are notched anteriorly for the passage of the radial nerve and have two long posterior projections, while the interradial plates are much simpler.

**Cloaca.**— The cloaca serves not only for the discharge of waste substances from the alimentary canal, but also has a most important respiratory function as described below. It is in sharp contrast with the extremely thin walled intestine in that it is provided with very powerful circular and radiating muscles. The former surround the cloaca closely, while the latter branch out radially and pass directly through the cœlom in all directions to connect the cloaca with the adjacent body walls (Plate XXX). The contraction of these radiating muscles causes the cloaca to open widely, while the circular muscles serve to close it. When the cloaca is opened, water rushes in from the outside through the cloacal aperture, and is thus forced up into the respiratory trees.

The cloacal opening is supported by a narrow ring of calcareous plates, with five posterior projections, termed "anal teeth ", situated in the five radii. There are also five groups of slender, sensory papillæ surrounding the opening.

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* Since the animal is represented as opened along the ventral side, the organs on the left side of the body are seen on the right-hand side of the figure. The fact that the mesentery attaching the posterior portion of the intestine to the right ventral interradius appears on the right-hand side of the figure shows that the cut has been made along the animal's *right ventral* interradius, between the mesentery and the right ventral radius. The radius which extends along the median axis of the figure is therefore the left dorsal, while the right dorsal and right ventral are seen on the left-hand side, and the left ventral and ventral on the right-hand side of the figure (compare Fig. 20).

**Respiratory Trees.***— The anterior end of the cloaca leads forward into a broad sac, which divides into a pair of very thin-walled tubes, the so-called respiratory trees. These are profusely branched (Plate XXX), and extend forward nearly to the anterior end of the body. Their very numerous broad-lobed ramifications (which are made too slender in the figure) expose a vast amount of surface to the cœlomic fluids.

The musculature described above enables the cloaca to be widely opened and filled with the external sea water. By closing the cloacal aperture this water is forced up into the respiratory trees under considerable pressure. In this way pure water is supplied to the branches of the respiratory trees, and because of the pressure a portion of the water is forced through the walls of the branches and enters the cœlom. This cavity is thus constantly filled with water, and the body walls kept tense and firm.

Such a continuous supply is necessary to replace the loss which constantly occurs by diffusion through the tentacles and tube-feet during the active movements of the animal.

By constantly pumping the water in and out of the cloaca the body receives a constant supply of pure water, bringing in the oxygen necessary for life, and carrying out the waste formed in the metabolic processes.

When the animal is disturbed and contracts its body violently, at the same time withdrawing its tentacles, the water in the respiratory trees is driven out of the cloacal aperture with such force that it forms a jet which may be ejected for a considerable distance.

In *Synapta* the respiratory trees are wanting. Instead, there are numerous ciliated funnels attached to the left dorsal mesentery which probably have an excretory function.

**Water-vascular System.**†— The ring canal at the base of the tentacles (Plate XXX) connects with radial canals which extend to the posterior end of the body between the two bands of longitudinal muscles in each of the five radii. Connected with the ring canal is the madreporic canal, which, strangely enough, ends in a madreporic plate situated in the midst of the cœlomic cavity, as shown in Plate XXX. The water of this cavity is thus used for the supply of the water-vascular system. Connected with the ring canal are the large Polian vesicles, which vary in number in different individuals from one to two, or even three. When three are present, one of them is usually quite rudimentary. They contain a reserve supply of fluid.

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* By injecting colored starch paste through the cloaca, the respiratory trees may be made to show all their branches with great distinctness.

† It is possible to inject the water-vascular system through one of the Polian vesicles with a colored fluid, such as Prussian blue solution. By this method the radial canals with their branches may be rendered quite conspicuous.

Scattered all over the internal surface of the body are the slender ampullæ connected with the tube-feet, or pedicels.

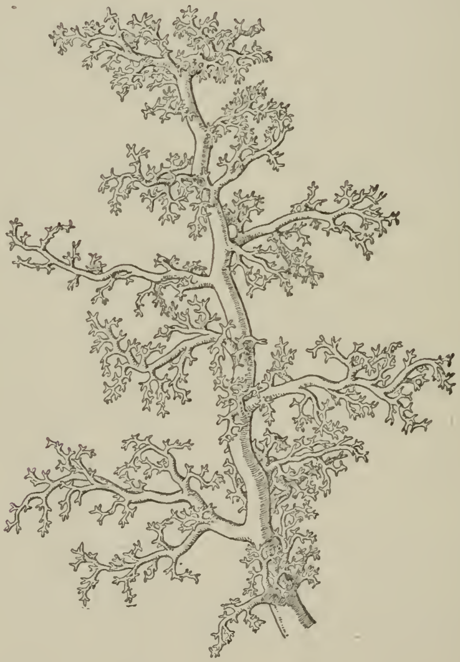

FIG. 21. *Thyone briareus.* One of the oral tentacles, showing the profusion of branches.

Both the very numerous pedicels, which occur in the inter-radial areas as well as in the radii, and the large, branched tentacles are connected with the radial canals of the water-vascular system. Both oral tentacles (Fig. 21) and pedicels are provided with muscular ampullæ, which receive the fluid when the pedicel or tentacle is contracted, as in the starfish.

In *Synapta,* in which pedicels are wanting, the water-vascular system is very rudimentary, and no radial canals occur, the tentacles being connected with the ring canal.

**Musculature.**— Paired bands of powerful longitudinal muscles extend the length of the body in each of the five radii, while transverse, or circular, muscles extend between the adjacent radii. In all except *Synapta* the circular muscles are interrupted at the radii.

Attached to the calcareous ring are powerful retractor muscles by means of which the crown of tentacles, and in fact the whole anterior part of the body, can be completely withdrawn. They are connected with the five pairs of longitudinal muscles well back toward the middle of the body (Plate XXX). In some specimens these retractors are split for the greater portion of their length into pairs, corresponding with those of the longitudinal muscles, but in other individuals the two parts of each muscle are firmly united.

The musculature of the cloaca is described above.

**Body Walls.**— In this species the walls of the body are so thick, tough and leathery that calcareous plates are wanting except at the anterior and posterior ends of the body. In all our other holothurians, however, characteristic plates are found in all parts of the walls. These plates, as well as those that are found in the tentacles and pedicels, are described in detail in the descriptions of the different species, for they are in each species of such characteristic form that they furnish the most reliable means of recognizing specific differences.

**Nervous System.**— The quick and vigorous response which the animal makes to various stimuli indicates a highly sensitive nervous system.

In its morphological structure, however, the nervous system, with its nerve ring and radial nerves, is closely similar to that described for the starfish.

**Reproductive Organs.**— The sexes are separate. The sexual gland is attached to the dorsal mesentery, and consists of a brush-like structure, composed of numerous slender filaments all converging to a central tube, the genital duct. In reality these filaments are in two clusters, one on each side of the mesentery, but are commonly so closely interwoven as to appear as a single cluster, as represented in Plate XXX. The genital duct passes forward as a slender canal in the dorsal interradius. It opens to the exterior in the mid-dorsal line between the bases of the dorsal tentacles. A small papilla marks the opening of this duct in the males.

## HABITS AND FOOD

The holothurians are usually very sluggish in their movements, although they respond suddenly and vigorously to various stimuli. Our native species live largely in the mud or sand between tides or on the sea bottom, moving slowly from place to place as conditions of food or other circumstance may require.

In the worm-like *Synapta*, locomotion is accomplished by the contractions of tentacles and body walls, while the other species are provided with very numerous pedicels or tube-feet by means of which they can creep about.

The species of *Synapta* live with the posterior end buried deeply in the sand or mud. In our other holothurians, however, the cloacal opening is connected with the respiratory apparatus. Hence in these species the body is usually bent into a U-shape with both ends near the surface of the sand or mud in which the animals live.

**Thyone.**—The habits of the common *Thyone* and its response to stimuli have recently been studied and described by Pearse.* Very little is known regarding the natural history of *Thyone unisemita* or *Thyone scabra*, for of these species very few specimens have ever been seen alive.

Living, active individuals of the common *Thyone* kept in an aquarium are most interesting creatures to watch. The delicately branched, purple oral tentacles (Plate XXXI) are constantly being alternately stretched out and withdrawn, the finer branches gliding over the materials on which the body is resting. If imbedded in mud or sand the tentacles spread out widely exploring the surface in all directions. By this means they come in contact with any particles of organic substance or small organisms which may be present. Such materials may then be grasped by one of the tentacles, which is then withdrawn into the mouth, and the adhering particles collected are scraped off to serve as food. The tentacle is then thrust out for further exploration. In such a manner quantities of mud containing more or less nutritive substance pass into the alimentary canal.

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* *Biological Bulletin*, 1908.

When living in sand, however, the animal is able to select the food materials and reject most of the particles of sand. Even when sand particles are conveyed into the mouth they are often brought out again when the tentacle returns in search of more food. The tentacles take their turn in conveying the food, and as a rule only a single tentacle enters the mouth at one time. Another tentacle may bring its catch near the mouth and wait for the first tentacle to be withdrawn before entering. An examination of the stomach contents shows the food to consist of protozoans, small worms, crustacea and other animals, together with diatoms, unicellular and filamentous algæ and fragments of other plants and animals.

The respiratory movements involve the whole body, the body walls expanding and contracting as the water is taken in and expelled from the cloacal opening. The discharged water often forms a jet of some force.

In its natural position, the common *Thyone* lies with the cloacal aperture widely opened and slightly elevated above the surface of the sand or mud. Through this opening water is alternately pumped into the cloaca and the respiratory trees and forcibly expelled. This act of respiration often occurs with a fairly definite rhythm, at intervals varying under different conditions from 15 seconds to more than a minute. The anterior end of the animal may also lie at the surface of the mud, with the main portion of the U-shaped body concealed beneath the surface. From time to time the animal buries also the anterior end and remains for hours with only the tip of the cloaca projecting. If disturbed, there is a sudden jet of water forced from the cloaca, and the end of the body is withdrawn beneath the surface. Even a shadow falling upon the sensory papillæ surrounding the cloacal opening is sufficient to cause this reaction.

If placed upon the surface of the sand the animals may either crawl about or bury themselves. They do not bore their way into the sand by means of the tentacles and anterior end of the body, as is described below for *Synapta,* but lie with the ventral side upon the surface of the sand, and, by alternately contracting and extending their bodies, push the sand aside and gradually sink beneath the surface. The pedicels of the ventral side of the body aid in pushing aside the particles of sand and drawing the body down.

**Cucumaria.**— According to observations of Grave* at Beaufort, North Carolina, *Cucumaria pulcherrima* likewise lives in a U-shaped tube near the surface of the mud near low-water mark. The individuals of this species even when very young show a remarkable sensitiveness to stimuli caused by vibrations, and quickly withdraw the tentacles at the slightest disturbance. Specimens reared from the free-swimming stage, however, and kept in the laboratory for two or more years lose the irritability characteristic of newly caught individuals, so that even when removed from the aquarium with such force as to tear off many of the tube-feet they may fail to draw in the tentacles.

When feeding, they extend the branched tentacles to half the length of the body and gather up the diatoms and other organic matter from the surface of the mud, as described for *Thyone.* In cold weather they cease feeding and remain for long periods of time with the tentacles withdrawn.

**Synapta.**— The common *Synapta* secures its food in the same way as *Thyone.*

In life the tentacles are almost constantly in action, reaching out in all directions to explore surrounding objects, the digits, or slender branches of the tentacles, being thrust out and curled up incessantly. They secure the food and serve in burrowing. In making the burrow, as described by Clark,† the animal bores vertically down into the sand with the oral end foremost. The tentacles are used to remove the particles of sand in front.

" Synaptas burrow into the sand head first, and almost always go straight downward for some distance, but when once completely buried, they turn in any direction up or down or on the horizontal plane. They can and do turn in their burrows, but as a rule they make new tubes when they come to the surface. They are seldom still, and the old idea that they remained in the tube they have formed with their tentacles just above the surface is scarcely true. Sometimes they assume that position, but seldom remain so very long. They rarely leave their burrows and come out on the surface of the sand, and I doubt if they ever do so under normal conditions.

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* Tentacle Reflex of a Holothurian, *Cucumaria pulcherrima. Johns Hopkins Univ. Circulars,* No. 5, pp. 24-27, 1905.

† *Bull. U. S. Fish Commission,* page 25, 1899.

" Passage through the sand is chiefly accomplished by means of contractions and extensions of the body, but is materially assisted by the tentacles. With the latter, which are almost continually in motion, the sand is loosened and the grains more or less separated. By the contraction of the longitudinal muscles the rear of the body is brought up nearer to the head, and then the circular muscles contract and extend the body again. It is prevented from slipping back by the anchors, which are elevated by the contraction of the circular muscles and hold against the sand. Since the contraction begins next to the rear end and moves forward, the head end is pushed onward, the anchors there lying flat in the skin.

" This process of alternate contractions of the two sets of muscles is very obvious to an observer, and takes place very continuously, though not rapidly. In this way a *Synapta* can move through the sand from 2 to 3 centimeters a minute, and an *inhærens* of average size can get entirely out of sight in 5 or 6 minutes. One of the most remarkable provisions for the use of the anchors in locomotion is *their much greater abundance and their considerably greater length in the posterior part of the body.* The use of this is clear when one realizes how the rear of the body acts as the resisting base against which the muscles work in pushing the anterior end forward."

## AUTOTOMY

Both *Thyone* and *Synapta* often exhibit the habit of self-mutilation or autotomy when subjected to very unfavorable conditions or strong stimuli. Such reactions, however, occur in very different ways in the two genera. Merely placing a *Synapta* in a jar of clean sea water without sufficient sand to enable it to bury itself will lead in a short time to violent contractions of the posterior end of the body, resulting in the spasmodic contraction of the circular muscles at certain points with such violence as to divide the body into two or more parts. The anterior part may continue to cut off successive pieces until only a small fragment of the anterior end of the body remains. This consists of the tentacles, calcareous ring, nerve ring, and circular canal of the water-vascular system, yet this fragment can under favorable conditions restore the normal proportions of the body.

The posterior fragments, severed from the nerve ring, may become much constricted but do not suffer further fragmentation. Such parts are unable to regenerate the whole body.

In *Thyone,* the mutilation consists in such powerful contractions of the body muscles as to cause the rupture of the body walls and longitudinal muscles immediately behind the calcareous ring. This results in the ejection of the nerve ring, circular canal of the water-vascular system, and a portion of the alimentary canal, together with the whole crown of tentacles. Pearse* describes a series of experiments to determine the conditions under which such autotomy occurs. Various chemical stimuli and foul water are the most effective agents in producing it. Such mutilation as occurs in *Thyone* is doubtless entirely pathological and probably causes the death of the animal in nearly all cases. Pearse makes the statement, however, that regeneration of the lost parts may ultimately occur.

## REGENERATION

In their regenerative processes some of the holothurians exhibit powers far beyond those of any other animals of such a high degree of specialization. When disturbed, certain species contract their bodies with such violence as to force out the greater portion of their viscera, including not only the cloaca and respiratory apparatus, but also nearly the whole of the alimentary canal. Under favorable conditions the normal body is restored. While none of our own species have either this habit or its compensating regenerative faculty, they are able to restore their normal proportions after very considerable mutilation.

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* *Biol. Bulletin,* vol. xviii, pp. 42-49, 1909.

The following interesting observations by Clark,* show the ability of the common *Synapta* to regenerate missing parts.

" A number of experiments were made to test the tenacity of life and the possibility of regeration in synaptas, and the results show that *inhærens* is not a very sensitive animal. If an individual is cut in two the anterior end will live and grow as well apparently as any normal specimen, but the posterior end will only live for a few hours, or perhaps a day. So far as I could see, the only reason for its death was its inability to take in food; and I am inclined to think that if food could be provided the posterior half would live as well as the anterior. It seemed to make no difference whether the bisection occurred near to the head or far from it; the head always lived, and in the course of two weeks would show perceptible signs of growth. All that seemed to be necessary was the mouth and a small part of the digestive tract. That it was not the tentacles which were essential was shown by the fact that synaptas lived all right without them. Two or more tentacles were cut from a number of synaptas — in two cases every one being removed — yet they all lived and burrowed in the sand with more or less ease; and not only did they live, but regeneration began at once, so that in two weeks the new tentacles were large enough to bear a digit on each side. At first I thought the nerve ring was the essential part, but that seems to be doubtful, for the nerve ring was carefully and completely severed in a synapta without apparently causing any inconvenience. In other specimens it was cut in two or even three places, but with the same result. In no case were any serious effects shown, and the animals lived and burrowed in the sand with apparently as much ease as ever. I made no microscopical examination to show whether the nerve ends reunited or not, but the cuts apparently healed in a short time. The most striking fact was that with the cutting of the nerve ring there was not the least evidence of any lack of coördination in the movements of the tentacles, nor of the muscles of the body."

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* *Bull. U. S. Fish Commission,* 1899.

## REPRODUCTION AND DEVELOPMENT

In the holothurians, as in the other groups of echinoderms, the sexes are usually separate. Most species of *Synapta,* however, are hermaphroditic, the sexual glands forming both eggs and spermatozoa, which mature at different periods.

The eggs of our common species are beautifully transparent, and have a very symmetrical type of cleavage, but are not so easy to fertilize artificially as are those of the starfish or sea-urchin.

Although three of the species inhabiting Long Island Sound are found in great abundance in certain localities, very little is known regarding their development. The absence of such knowledge seems the more remarkable when we consider the fact that the eggs of all three species are matured in summer, when the opportunities for investigating problems in marine biology are most favorable.

Grave* has been successful in rearing the free-swimming larvæ of *Cucumaria pulcherrima* from the fertilized eggs. He has also observed the transformations to the adult form and has even been able to keep the young holothurians alive in the laboratory for two or three years. This has been accomplished by furnishing the animals with an abundant supply of diatoms and other minute organisms growing at the surface of a layer of sand. The method consists in introducing into the aquarium a small quantity of the surface sand which has been dredged from the ocean bottom and allowed to stand in a jar of sea water for several days. The surface will then be found to be covered with a film of diatoms. The aquarium with the larvæ to be reared, after receiving a small quantity of this diatom culture, is covered and placed before a window where it will be well lighted but not exposed to the direct rays of the sun. The diatoms grow, and furnish an abundant supply of the natural food of the animals, and at the same time keep up a constant supply of oxygen. The water may be changed every few weeks to replace the salts used by the diatoms and echinoderms.†

As in other groups, the eggs of the holothurians in which the development is known, give rise to free-swimming embryos, which are at first somewhat similar to those of the starfish, and are termed *auricularia*. In the later stages, the embryos of many species become barrel-shaped.

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* *Johns Hopkins Univ. Circulars,* No. 5, pp. 24-27, 1905.

† C. Grave. A Method of Rearing Marine Larvæ. *Science,* vol. xv, pp. 579-580, 1902.

After swimming and feeding at the surface for several weeks the embryo settles to the bottom and transforms itself into a young holothurian.

In a few species from other parts of the world, the young develop within the body cavity of the parent.

## KEY TO SPECIES

The class Holothuroidea is conveniently divided into two orders, based on the characters of the water-vascular system and the distribution of pedicels:— (1) the *Actinopoda,* in which the radial canals of the water-vascular system are well developed and supply the oral tentacles, and (2) the *Paractinopoda,* in which the radial canals and pedicels are absent, the oral tentacles being supplied from the circumoral canal. The first order includes our species of *Cucumaria* and *Thyone,* and the second order includes the two species of *Synapta*.

The following key will serve to distinguish our native species:

1. Pedicels present; body not very slender..................2
   Pedicels wanting; body slender and worm-like............5
2. Pedicels scattered over the whole body..................3
   Pedicels mainly limited to the five ambulacral regions; body whitish ......................**Cucumaria pulcherrima**
3. Ventral ambulacral area conspicuously demarcated by a distinct border free from pedicels; color white, yellowish white, or flesh-color.................**Thyone unisemita**
   Ventral ambulacral area not conspicuously demarcated; pedicels very numerous all over body; color brown or black ..........................................4
4. Body tapering posteriorly, but not attenuated; pedicels delicate; few calcareous plates in body wall. **Thyone briareus**
   Body attenuated posteriorly; pedicels and body wall rough from closely crowded calcareous plates...**Thyone scabra**
5. Color white or yellowish; the five radial plates of calcareous ring perforated for passage of nerve..**Synapta inhærens**
   Color reddish or pink; radial plates of calcareous ring notched in anterior border.............**Synapta roseola**

### **Cucumaria pulcherrima** (Ayres)

Plate XXXII, figs. 2 to 6.

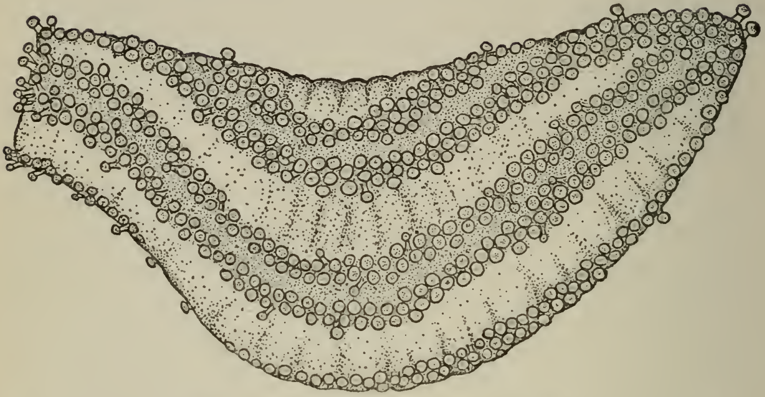

FIG. 22. *Cucumaria pulcherrima.* Specimen preserved in alcohol, showing ambulacral areas and arrangement of tube-feet (pedicels). Five times natural size.

This pretty little holothurian, formerly known as *Pentamera pulcherrima,* has been collected at many localities from Vineyard Sound to South Carolina, although very few specimens have been taken from their natural habitat. Living animals are rarely found even in systematic dredging. In certain localities, however, considerable numbers are washed up on the beach after hard storms. Most of the specimens in collections have been secured in this way. The species has been dredged at least once in Vineyard Sound, although in very thorough dredgings in the same region during several subsequent years no specimens were secured. In the very locality where large numbers of individuals have been washed up on the beach during the winter, systematic search by means of dredgings on the bottoms off shore the following summer were without success. It has been found on the beach after severe storms at several localities on the Connecticut shore. Among the seaweed thrown up by the waves on the rocky points both east and west of New Haven, the species has been found repeatedly during the colder months of the year.

In the harbor of Beaufort, North Carolina, the species occurs near low-water mark in muddy localities where there is a growth of eelgrass. Grave has reared the larvæ to the adult form, and has succeeded in keeping the young holothurians to the age of two or three years by the methods described on page 128.

Color white or pale yellowish. Size usually about 1 inch long and a half-inch in diameter; rarely reaching a length of 2 inches.

In such specimens as are washed up by the waves the body is oval, sometimes tapering towards one end; with a distinct curve, the two ends being bent dorsally, with the result that the length of the body measured along the ventral surface is much greater than if measured along the dorsal surface.

There are ten much branched tentacles, of which the two ventral are much smaller than the others, as in *Thyone*. In the specimens found on the beach they are usually fully retracted into the body, as shown in Plate XXXII, figs. 2 to 6.

The tube-feet, or pedicels, are rather stout, and are strictly limited to the five ambulacral regions, or radii (Fig. 22).

The cloacal opening is surrounded by five small groups of pedicels which are stiffened with thickly placed calcareous deposits (Fig. 23). Imbedded in the body walls in all parts of

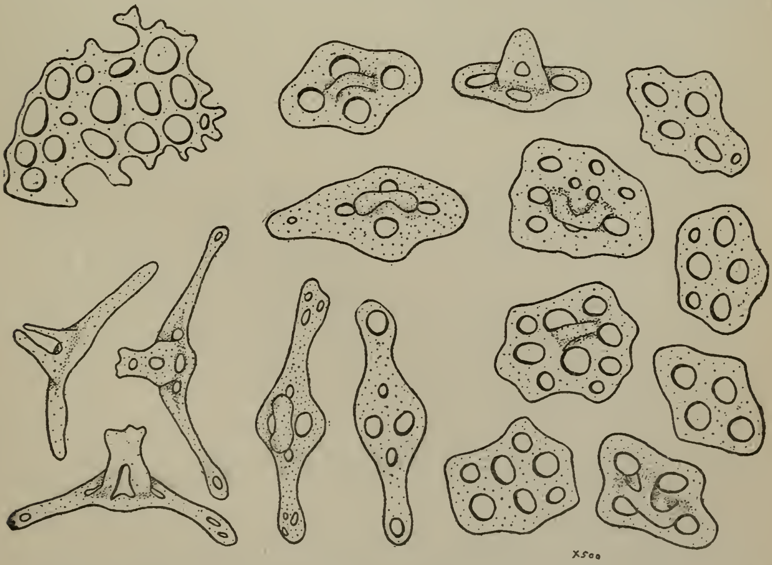

FIG. 23. *Cucumaria pulcherrima.* Outlines of calcareous plates. The upper left-hand plate is from a tentacle; the three lower left-hand plates are from the pedicels; all the others are from the body wall. (× 300.)

the body are closely crowded calcareous deposits of characteristic form (Fig. 23). They greatly increase the firmness of the integument. Some of these deposits are quite symmetrical, while others are very irregular. The most typical shape is that of a table in form of a parallelogram, perforated by four oval holes, and surmounted by a spire consisting of two rods with a few sharp points at the apex (Fig. 23). Others are rectangular, with six holes, and a small spire. Still others have eight, ten, or occasionally more holes. Some are considerably elongated, and, when unusually slender, have one or two small holes in each extremity. The vast majority have graceful, curved or wavy outlines, and are remarkably symmetrical. At the posterior end of the body the tables become densely packed together, and are of much larger size than those found elsewhere. Near the cloaca the spire of the tables becomes much reduced, the deposits assuming the form of large perforated plates.

The cloacal opening is supported by a ring of crowded calcareous plates of large size, but quite irregular in shape (Fig. 24).

In the pedicels the calcareous deposits are slender tables, and near the extremity are reduced to supporting rods with perforated ends. The tip of each pedicel has a terminal perforated plate (Fig. 24).

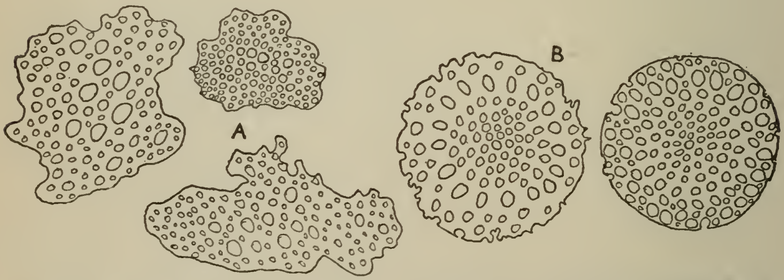

FIG. 24. *Cucumaria pulcherrima.* Outlines of calcareous plates. *A,* from cloaca; *B,* terminal disks of pedicels. (× 150.)

In the tentacles there are a few small plates of very irregular outline, with an occasional one of much larger size.

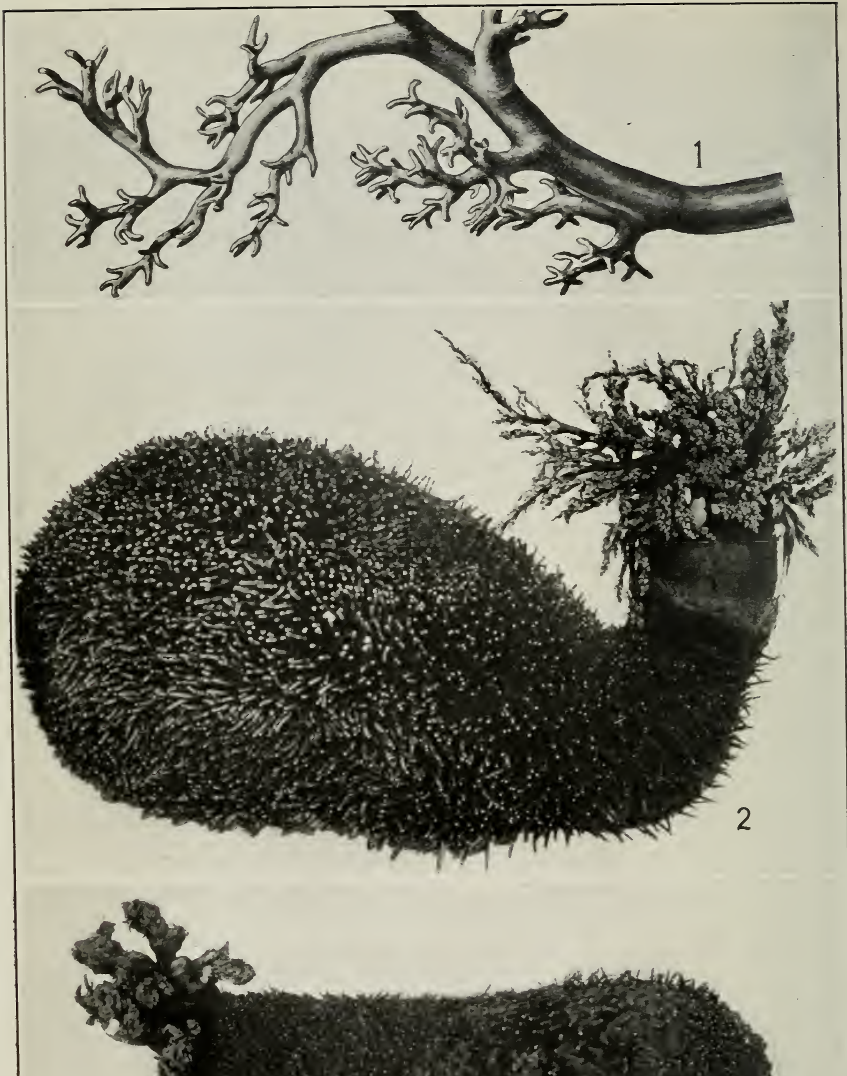

PLATE XXXI. Common Thyone, *Thyone briareus*.

### Thyone briareus (Leseur)

Common Thyone

Plate XXIX, fig. 5; Plates XXX and XXXI.

This species is distributed from Vineyard Sound to the Gulf of Mexico, occurring from near low-water mark to a depth of ten fathoms on both sandy and muddy bottoms. In certain localities it is very abundant, while in seemingly equally favorable situations it does not occur. It is commonly found buried in soft mud in shallow water, often with its body bent into a U-shape, with both extremities at the surface of the mud. In this position its much branched, purplish tentacles stretch out on the surface of the mud in search of the fine particles of organic matter which constitute its food. The posterior end, with the cloacal aperture usually widely opened, likewise reaches the surface of the mud and alternately sucks in and discharges the water used in respiration. The species is often found at the bottom of streams and creeks where the water is decidedly brackish.

The color of the body is purplish, brownish, or blackish, the pedicels lighter, often with a reddish cast, and the terminal disks yellowish.

The body when mature may become six or even nine inches in length when fully extended, most individuals, however, being about three or four inches long and an inch or more in diameter. In shape, the animal is largest in its middle portions, being somewhat narrower anteriorly, and tapering decidedly toward the posterior end (Plate XXXI); but the whole body may become regularly oval or much rounded in certain states of contraction.

The mouth, situated in the center of the anterior end, is surrounded by a crown of ten tentacles, of which the two ventral are much smaller than the others. All are profusely branched, as shown in Fig. 21. The bases of these tentacles and their larger branches are stiffened by the development of numerous

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Explanation of Plate XXXI. *Thyone briareus.*

Fig. 1. Portion of one of the oral tentacles, showing the terminal finger-like processes. Much enlarged.

Fig. 2. Large specimen with oral tentacles expanded, and pedicels fully extended. Natural size.

Fig. 3. Preserved specimen with oral tentacles partially contracted. Natural size.

perforated calcareous plates, and somewhat similar plates occur more sparingly in the smaller branches. They are either rod-like or broad, and are commonly perforated by six or more holes (Fig. 25).

The body walls, especially in mature specimens, are without calcareous deposits in the greater part of the body. At both extremities, however, there are numerous peculiar calcareous deposits known as "tables." These tables are more or less nearly square or rectangular, and are perforated by about eight rounded holes. At right angles to this plate is the so-called spire, made up of about four short rods ending in teeth and connected by one or two cross processes (Fig. 25).

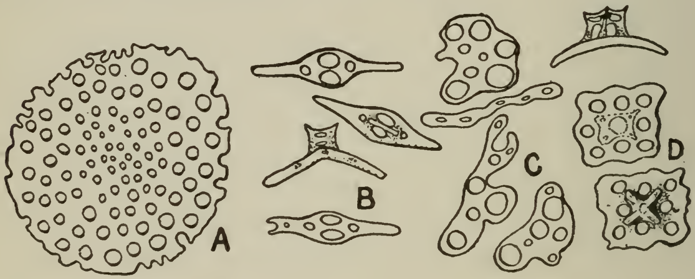

FIG. 25. Outlines of calcareous plates of *Thyone briareus*. *A*, terminal plate of pedicel; *B*, supporting plates of pedicels; *C*, plates from tentacles; *D*, plates (tables) from body-walls.

The slender pedicels, or tube-feet, are very numerous, and are scattered irregularly all over the body. Occasionally they appear to be arranged in five very broad longitudinal bands, although such bands are not distinctly separated from each other. The pedicels of the ventral surface are broader than those of the dorsal side of the body, the latter commonly tapering to a point. In the extremity of the pedicel is a terminal circular plate (Fig. 25), perforated by many minute holes. In the walls of the pedicels are other perforated plates, some of which are modified to form supporting plates, while others are provided with a short spire (Fig. 25).

The cloacal opening has five groups of small papillæ, and a calcareous ring with the five tooth-like processes known as the anal teeth.

The calcareous ring at the base of the tentacles is very broad, and the radial plates have rather slender prolongations.

The internal anatomy of this species is described in detail on pages 116 to 122, and is illustrated on Plate XXX. The habits and reactions to stimuli have recently been studied by Pearse, and are described in an interesting article in the *Biological Bulletin,* Vol. XV, pp. 259-288, 1908. The sexual products mature in June.

### **Thyone unisemita** (Stimpson)

Single-striped Thyone

Plate XXXII, fig. 1.

In the earlier writings of Ayres and Verrill this species was placed in the genus *Stereoderma,* and as such appears in Verrill and Smith's Invertebrate Animals of Vineyard Sound. There are few available records of the collection of this species in Long Island Sound. The United States Fish Commission collected twelve specimens off Watch Hill, Rhode Island, at a depth of eleven fathoms. Six of these specimens are preserved in the Yale University Museum. The Fish Commission likewise records the collection of two other specimens in Long Island Sound, but without giving the number of station or precise locality. The species has also been dredged on sandy bottoms at various localities from southern New England northward to the Banks of Newfoundland, but has nowhere been found in abundance.

The living animals are white, flesh-colored, or yellowish white, with orange-yellow tentacles. Most specimens are less than two inches in length, although one individual measuring three inches in length has been recorded.

The body is somewhat U-shaped, and narrowed at both ends. The pedicels cover the dorsal and lateral surfaces, but on the ventral side there is only one double row situated along the mid-ventral line. This row is rendered the more conspicuous because it is bordered on each side by a wide area of smooth skin, giving the characteristic effect of a single ventral stripe.

The calcareous deposits in the body wall (Fig. 26) consist of flattened plates, many of which are symmetrical and perforated by four holes. Others are larger, irregular in outline, and with

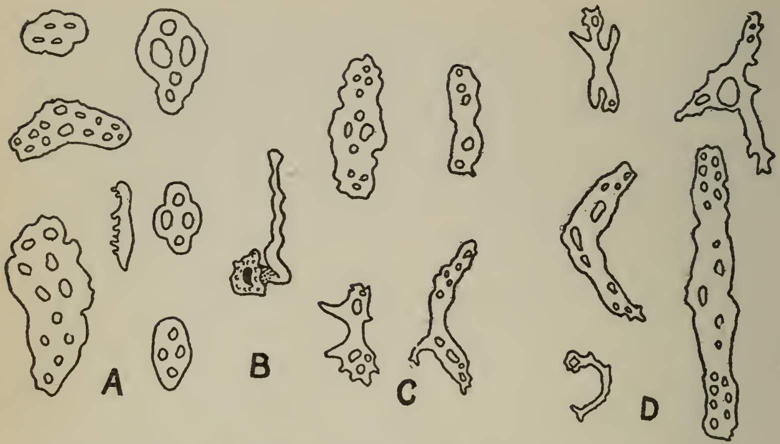

FIG. 26. *Thyone unisemita.* Outlines of calcareous plates. *A,* from body-wall; *B,* madreporic plate; *C,* from pedicels; *D,* from tentacles. (After Clark.)

numerous perforations. The madreporic plate and the characteristic plates of the pedicels and tentacles are shown in Fig. 26.

Further details of the anatomy may be found in Clark's Report on the Echinoderms of the Woods Hole Region.

### **Thyone scabra** Verrill

Rough-skinned Thyone

Plate XXXII, fig. 7.

This species has not as yet been recorded from Connecticut waters. It is, however, included in this report because it has been collected near the eastern entrance to Long Island Sound, and is reported from Narragansett Bay. Hence its occurrence

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EXPLANATION OF PLATE XXXII.

Fig. 1. *Thyone unisemita.* Three specimens preserved in alcohol, with completely retracted peristome and tentacles. Slightly enlarged.

Figs. 2-6. *Cucumaria pulcherrima.* Five specimens after preservation in formalin, showing variations in shape of body and ambulacral areas. Slightly enlarged.

Fig. 7. *Thyone scabra.* Preserved specimen with extended peristome, and partially extended tentacles. Slightly enlarged.

Fig. 8. *Synapta inhærens.* Anterior portions of body of two individuals with partially contracted tentacles. Natural size.

Fig. 9. *Synapta inhærens.* Posterior portion of body, showing two of the five longitudinal muscular bands. Twice natural size.

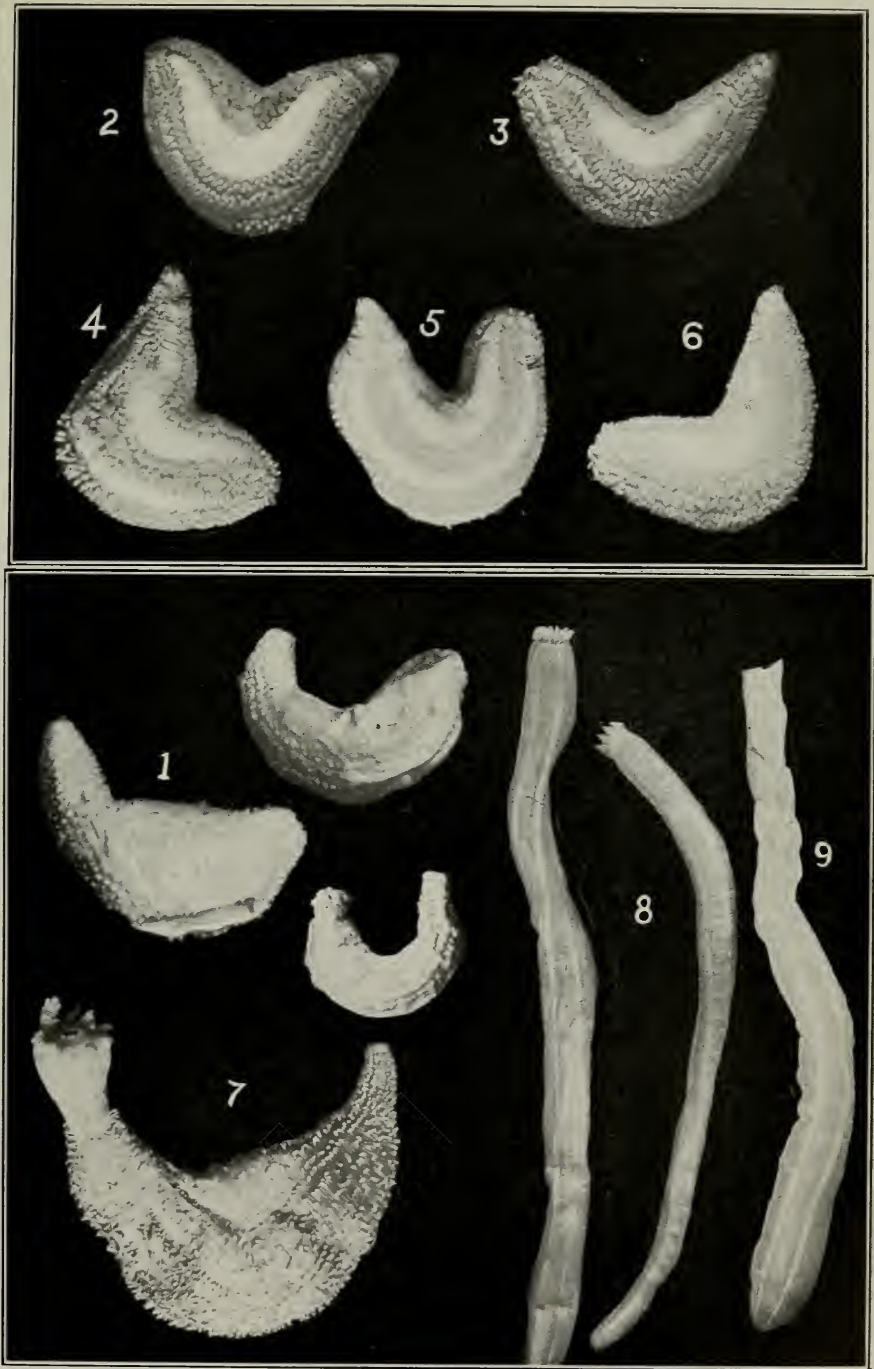

PLATE XXXII. *Thyone, Cucumaria, and Synapta.*

is probable in the colder and deeper waters at the eastern end of the Sound.

The species ranges northward to the Bay of Fundy, and has been reported as far south as Delaware, although the record for the last-named region may not be without question. It extends from shallow water to a depth of more than 600 fathoms.

There are no records as to the color or general appearance of the living animal, the species having been studied and described from preserved specimens. When preserved in alcohol, the color is brownish, with lighter pedicels. Nothing is known regarding its habits.

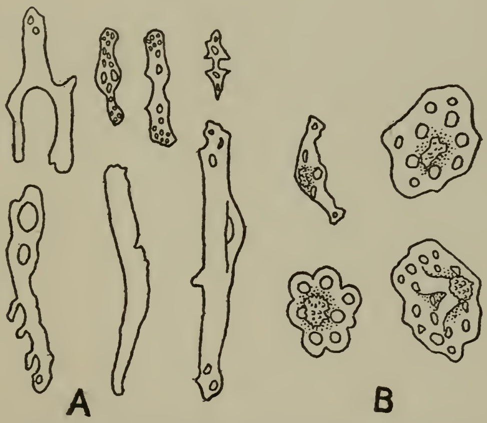

FIG. 27. *Thyone scabra.* Outlines of calcareous plates. *A,* from tentacles; *B.* from body-wall. (After Clark.)

The individuals of this species are very much smaller than those of the common *Thyone,* rarely exceeding two inches in length. The body is slender posteriorly and pointed at the extremity.

The most striking characteristic of the species is the abundance of the calcareous deposits in the skin. These are placed so closely together as to cause a decided roughness over the whole surface of the body. The deposits consist mainly of irregular plates (Fig. 27), usually pierced by eight to twelve or more holes, and provided with a rather small handle, or spire. The spire is made up of two or three stout columns, united at the top and crowned with small, irregular teeth.

The plates in the pedicels are narrow and curved, with four central perforations besides one or more holes at each end; while those of the tentacles are rod-like, often with irregular outline, and perforated (Fig. 27).

For other anatomical details see Clark's Report in the Bulletin of the U. S. Fish Commission for 1902, or Verrill's original description.*

### Synapta inhærens (O. F. Müller)

### Common Synapta

Plate XXIX, figs. 3, 4; Plate XXXII, figs. 8, 9.

It was formerly thought that the common New England *Synapta* represented a distinct species, to which the name *Leptosynapta girardii* was applied, and this name is used in Verrill and Smith's Report on the Invertebrate Animals of Vineyard Sound. It has been shown, however, that our form is specifically identical with the well-known European *Synapta inhærens.* A very complete description of the anatomy and habits of this species has been published by Clark, in the Bulletin of the U. S. Fish Commission for 1899.

This is a very widely distributed species, being found not only on the Atlantic coast of the United States and along the European shore from the Arctic Ocean to the Mediterranean Sea, but also on the Pacific coast of North America from Alaska to Monterey Bay and Point Loma, California. It also occurs at Bermuda.

Along the Connecticut shore it is very commonly distributed, and occurs in a great variety of situations.

It is most frequently seen on sandy flats between tides, where its burrows can be recognized, when the water is low, by the small mound of sand commonly of different color from that at the surface. In the center of this mound can be seen the small hole in which the creature is living. This hole descends perpendicularly, with a diameter of from one-fourth to three-eighths of an inch.

Although most commonly found in clean sand, it also occurs in muddy situations, and can even live in soft, black mud.

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***Am. Journ. Science,* ser. 3, vol. v, 1873.

Furthermore it is often found in coarse gravel, and sometimes beneath large stones. And finally, it occurs not only between tides, where the mouths of its burrows may be exposed to the air for an hour or more, but also below low-water mark, extending to a depth of over 100 fathoms. When found in sand between tides its body remains deep in the wet sand beneath the surface, where there is an abundance of water for respiration.

Its ability of adapting itself to such a wide range in the character of its environment, probably accounts for its very wide geographical distribution.

The body is long, slender, cylindrical and worm-like, and capable of great extension. It is so delicate and fragile that complete specimens are difficult to preserve intact. Its length is often 4 to 6 or more inches, with a diameter of ¼ to ⅜ of an inch.

The color of the body is white, often with a distinct tinge of yellow and occasionally of very pale red. The rosy hue of some specimens is due to minute particles of red pigment in the integument, but the reddish color is never so distinct as in the succeeding species. The integument is thin and delicate, and often so translucent that the five bands of longitudinal muscles, which are opaque white in color, and certain of the internal organs, can be distinguished in the living animal. This is particularly true of the intestine, which is filled with sand, and of the reproductive organs when the sexual products are mature.

There are twelve tentacles (Plate XXIX, fig. 3), with characteristic branches. Each tentacle commonly consists of a main stalk and five or seven pairs of branches (Plate XXIX, fig. 4), though there are occasionally only three pairs. The branches are tubular or finger-like projections, and are termed digits. Each tentacle has a number of peculiar sense organs on the inner surface near the base. Calcareous deposits, consisting of oval or knobbed plates or rods, occur in the tentacles.

The most characteristic features of the species of this genus, however, are the very remarkable calcareous deposits found in the body walls. These consist of structures resembling miniature anchors, each of which is connected with a perforated plate of characteristic design (Fig. 28). These occur in all parts of the body,* but are smaller anteriorly than elsewhere, increasing gradually in size toward the posterior end of the body.

The anchor has a narrow shank, with rather short arms; on the outer side of the flukes are several minute spines. The shank is narrowed near the point where it joins the short, slightly curved stock.

The plate, or table, on which the anchor rests has seven symmetrically placed perforations, with serrated margins, followed by a transverse row of three oval perforations, with smooth margins, and several small, smooth holes toward the posterior border. Forming an arch above the three oval perforations is a short transverse process, raised above the level of the plate by a pair of supports at each end (Fig. 28).

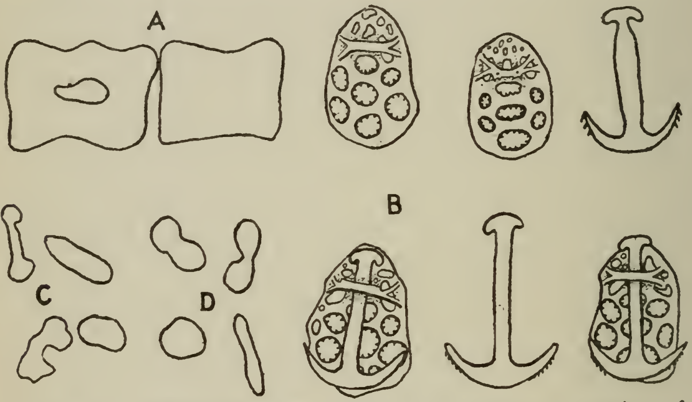

Fig. 28. *Synapta inhærens.* Calcareous plates. *A,* portion of calcareous ring; *B,* anchors and plates from body-wall; *C,* plates from tentacles; *D,* plates from longitudinal muscles. (*A, C,* and *D* after Clark.)

The calcareous ring is broad, the plates being without projections on either side. The radial plates are perforated near the center for the passage of the radial nerves. This character alone will serve to distinguish this species from the following. Of the internal anatomy, it is necessary to mention only the large, spiral intestine, which extends the whole length of the body, the single

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* These anchors and plates make most beautiful microscopic objects. They can be prepared by soaking a piece of the body wall in a solution of caustic potash until it is thoroughly softened, when it can be washed in water, and the deposits mounted as desired.

Polian vesicle, the terminal cloaca, and the very slender filaments of the gonads. Respiratory trees are absent, and, as the body is without pedicels, the radial vessels of the water-vascular system are wanting in the adult.

In Long Island Sound the animals are sexually mature in the late spring and early summer. The eggs appear fully ripe during the last week in May on the sand flats of Savin Rock. Attempts at artificial fertilization have not been successful.

When removed from its burrow, the animal is very restless, and, if it is roughly handled, or if the water becomes stale, the posterior portion of the body is likely to break into numerous pieces.

This species secures its food by extending its tentacles upon the surface of the sand at the mouth of its burrow, and grasping with the digits such particles of organic substances and sand as may be selected. In this way vast quantities of sand are devoured, the digestible substances contained among the particles or adhering to them being absorbed. The intestine is always filled with sand or mud, which may be of such a color as to affect the coloration of the posterior part of the body.

The presence of the anchors in the integument enables the animals to cling closely to objects with which they may come in contact. It thus often happens that, when specimens of *Synapta* are collected with specimens of other animals, and placed in a jar of water, the whole collection may become entangled into an inextricable mass.

Specimens may be kept alive in an aquarium with a deep layer of clean sand in the bottom, for some weeks, if there is a constant supply of pure sea water.

### **Synapta roseola** (Verrill)

Pink Synapta

Plate XXIX, figs. 1, 2.

This beautiful little holothurian resembles the preceding species closely, but is easily distinguished by the granules of red pigment scattered so thickly over the body as to give it a delicate rose-pink color. It has, moreover, certain anatomical peculiarities by which it can be recognized, even after the color has disappeared from preserved specimens. Individuals of this species are usually smaller than those of S. *inhærens,* fully mature specimens rarely measuring much over 4 inches in length and ¼ inch in diameter.

The body is slender and cylindrical, with a crown of delicate tentacles at the anterior end. It is, as in the preceding species, very fragile. The animal is prone to break up the posterior portion of its body into many pieces when removed from its burrows. The color is pink, pale red, or sometimes fairly deep red, occasionally with a tinge of yellow. The color is mainly due to deep red granules of pigment scattered over the integument, particularly in the anterior portion of the body. When contracted, the color naturally becomes more intense than when extended. When sexually mature the filamentous gonads are conspicuous through the delicate body walls.

This species ranges from Massachusetts Bay to Long Island Sound, and is very abundant at Bermuda. Although it is locally distributed, it is very common in certain places.

The sexual products are ripe in summer, the genital glands at that time filling the anterior portions of the body, and plainly visible through the translucent body walls. Occasionally the eggs may be artificially fertilized and reared to the stage of free-swimming larvæ, but for some unknown reason the majority of attempts at artificial fertilization have been unsuccessful.

Its habits are somewhat different from those of *Synapta inhærens,* for this species is more commonly found in coarse gravel and beneath and between stones. It sometimes occurs in sand. In certain localities specimens may be most easily obtained by turning over the stones beneath which the animals live. It occurs both between tides and below low-water mark.

The anatomical peculiarities which distinguish this species from *Synapta inhærens* are fully discussed by Clark.*

Each of the twelve tentacles has usually but two or three pairs of digits (Plate XXIX, figs. 1 and 2). The calcareous deposits in the tentacles are very irregular, much branched, or perforated, while those in the longitudinal muscles are irregular or incomplete rings (Fig. 29).

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* The Synaptas of N. E. Coast. *Bull. U. S. Fish Commission,* 1899.

The anchors and plates which are found in all parts of the body wall are very similar to those in *S. inhærens,* but both

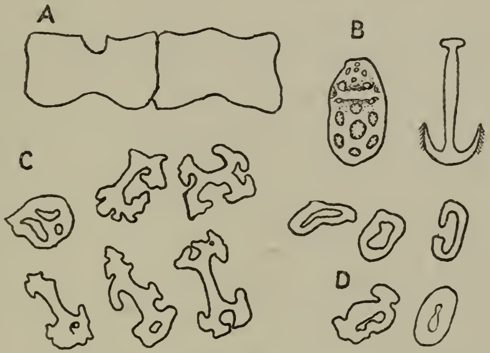

FIG. 29. *Synapta roseola.* Calcareous plates. *A,* portion of calcareous ring; *B,* anchor and plate from body-wall; *C,* plates from tentacles; *D,* plates from longitudinal muscles. (After Clark.)

anchors and plates have a tendency to be more slender (Fig. 29). It is the calcareous ring, however, which furnishes the most precise criterion of distinction, for in this species all the plates are rather narrow, and the radial plates have a notch on the anterior border for the passage of the radial nerve (Fig. 29), instead of the perforation found in *S. inhærens* (Fig. 28).

Both species occur on the sand flats at Savin Rock, near New Haven, in great abundance.

Clark, in his extensive Monograph on the Apodous Holothurians (Smithsonian Contributions to Knowledge, vol. XXXV, 1907), has revised the old genus *Synapta* and now places our two native species, *inhærens* and *roseola,* in Verrill's genus *Leptosynapta.* Although his reasons for doing this appear to be perfectly valid, it has been thought best to retain the long familiar generic name in the present work.

## BIBLIOGRAPHY

Of the vast amount of literature relating to the Echinoderms, the following list contains only a few of the books and papers which treat of the subject in such a comprehensive manner as to be useful to the general reader, or which have special reference to the species found in Connecticut waters. Of the latter only such have been selected as are referred to in the text of the article. In order to make the list as brief as possible, many papers of great importance to the professional zoölogist have been purposely omitted.

The articles are arranged in alphabetical order, with the date immediately following the name of the author for convenience of reference.

**Agassiz, A.** 1872-1874.

Revision of the Echini. *Ill. Cat. Mus. Comp. Zoöl.*, No. 7.

A most important work on the structure and relationships of the echinoids.

**Agassiz, A.** 1877.

North American Starfishes. *Mem. Mus. Comp. Zoöl.*, Vol. v, No. 1.

A beautifully illustrated monograph on the external anatomy of our native starfishes.

**Agassiz, Elizabeth C.** and **Alexander.** 1865.

Seaside Studies in Natural History. Marine Animals of Massachusetts Bay. Radiates. Boston. Houghton, Mifflin and Company.

This little book contains a popular account of some of our most interesting marine invertebrates, including many of the echinoderms.

**Arnold, Augusta Foote.** 1901.

The Sea Beach at Ebb Tide. New York City. The Century Company.

A well illustrated and interestingly written guide to the study of the marine invertebrates and plants.

**Ayres, W. O.** 1851-1854.

Notices of Holothuriæ and other Echinoderms. *Proc. Bost. Soc. Nat. Hist.*, Vol iv.

Although written more than a half-century ago, the descriptions of the natural history of many of our native species are as interesting as any that have been published since.

**Bather, F. A.**, assisted by **Gregory, J. W.**, and **Goodrich, E. C.** 1900.

The Echinoderma. Lankester's Treatise on Zoölogy, Pt. iii.

One of the most valuable works on the general anatomy, relationships, and natural history of the group.

**Brooks, W. K.**

Handbook of Invertebrate Zoölogy.

A well-known guide to the laboratory study of invertebrates.

**Clark, H. L.** 1899.

The Synaptas of the New England Coast. *Bull. U. S. Fish Commission.*

A clearly written and well illustrated report on our two native species of *Synapta.*

**Clark, H. L.** 1901.

Synopsis of North American Invertebrates. XV. The Holothuroidea. *American Naturalist,* Vol. xxxv, 1901.

A brief account of the anatomical peculiarities of the holothurians, followed by analytical keys to the genera and species found on both the Atlantic and Pacific coasts of North America.

**Clark, H. L.** 1904.

The Echinoderms of the Woods Hole Region. *Bull. U. S. Fish Commission* for 1902.

Concise systematic descriptions of nearly all the species of echinoderms found in the waters of southern New England. Each species is illustrated by excellent photographs, most of which were made from living animals.

**Fewkes, J. W.** 1887.

On the Development of the Calcareous Plates of *Amphiura. Bull. Mus. Comp. Zoöl.,* Vol. xiii, No. 4.

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A classic monograph on the holothurians.

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Ophiuridæ and Astrophytidæ. *Ill. Cat. Mus. Comp. Zöol.,* No. 1.

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# State of Connecticut

State Geological and Natural History Survey

**BULLETIN No. 20**

# THE
# BIRDS OF CONNECTICUT

By
JOHN HALL SAGE, M.S.
Secretary of the American Ornithologists' Union
and
LOUIS BENNETT BISHOP, M.D.
Fellow of the American Ornithologists' Union
assisted by
WALTER PARKS BLISS, M.A.

# BULLETINS

OF THE

# State Geological and Natural History Survey of Connecticut.

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1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.

2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.

3. A preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.

4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.

5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.

6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.

7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory and Henry Hollister Robinson.

8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.

9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.

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15. Second Report on the Hymeniales of Connecticut: by Edward Albert White.

16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part I. General Introduc-

tion: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

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19. Echinoderms of Connecticut: by Wesley Roscoe Coe.

20. The Birds of Connecticut: by John Hall Sage and Louis Bennett Bishop, assisted by Walter Parks Bliss.

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# State Geological and Natural History Survey

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## BULLETIN No. 20

HARTFORD
Printed for the State Geological and Natural History Survey
1913

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# The Birds of Connecticut

By
JOHN HALL SAGE, M.S.
Secretary of the American Ornithologists' Union
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# Introduction

Facing Long Island Sound for practically all of its hundred miles of southern border, Connecticut shows a succession of low, rocky promontories and sandy beaches divided by shallow bays and salt marshes. The latter stretch for varying distances northward, but soon give place to rather broad stream valleys, separated by gently rising hills. These hills, usually low and rounded at the coast, when not dikes or sheets of trap, as near New Haven, become rapidly more mountainous in the northwestern part of the state, culminating in Bear Mountain in the extreme corner, 2,354 feet in altitude and sixty miles from the Sound.

The soil of these hills is usually poor and shallow, while that of many of the valleys is deep and rich, so that, while the lowlands are well cultivated and thickly settled, the uplands are generally left to brush land or forest. From this configuration it will be evident that most of the streams are short and flow in a southerly direction. Three main river courses cross the state: — the Thames on the east, which for its lower quarter is practically an arm of the sea, and above that hardly more than a small stream; the Connecticut, which passes through the center, in a broad and fertile valley in its upper course, and in a narrow valley hemmed in by highlands below Portland; and the Housatonic in the western part, with a narrow and much more mountainous valley. Apparently the Connecticut and upper Housatonic valleys and the southern coast line are highways for the migration of our birds in spring, and the coast line certainly is in fall, but our information on this point is at present very incomplete.

The woodland consists chiefly of deciduous trees, though hemlocks and cedars are common, and groves of white pine and spruce still exist in the northwestern portion.

Shut off from the ocean by Long Island, strictly pelagic birds are seldom found in Connecticut, but for many other species it is particularly fitted as regards climate and topography. Over 135 species nest more or less regularly within its borders, and it is probable there are few localities in our country where so many can be found within so circumscribed an area. Almost the entire state lies in the Alleghenian Zone, where such birds as the Ruffed Grouse, Red-shouldered Hawk, Kingbird, Least Flycatcher, Bobolink, Baltimore Oriole, Goldfinch, Towhee, Indigo Bunting, Scarlet Tanager, Red-eyed, and Warbling Vireos, Black and White, Yellow, and Chestnut-sided Warblers, Catbird, Brown Thrasher, Chickadee, Wood, and Wilson's Thrushes, nest abundantly. Along the southern border and for some distance up the Housatonic and Connecticut valleys, the breeding, often in abundance, of such species as the Clapper Rail, Fish Crow, Acadian Flycatcher, Orchard Oriole, Seaside Sparrow, White-eyed Vireo, Worm-eating, Blue-winged, Prairie, Hooded, and Kentucky Warblers, Louisiana Water-thrush, and Yellow-breasted Chat brings this district within the northern limits of the Carolinian Zone; while the occasional, and in some cases regular, breeding of the Canadian Ruffed Grouse, Goshawk, Yellow-bellied Sapsucker, Alder Flycatcher, Savannah, and White-throated Sparrows (?), Blue-headed Vireo, Black-throated Blue, Magnolia (?), Blackburnian, and Canadian Warblers, Winter Wren (?), Red-breasted Nuthatch, and Hermit Thrush, in the northwestern part of Litchfield County, shows at least strong Canadian elements in the avifauna, though it may not be enough to include that district in the Canadian Zone.

Interest in our birds must have existed among many in the earlier days of Connecticut, and scattered references to them may be found in many volumes; but the first definite list of the birds of the state was written by the Rev. James H. Linsley, of Stratford,[1] and published in the American Journal of Science and Arts in 1843. He recorded 302 species, but of these Dr. Merriam[2] concluded that only 239 distinct species had been reported on satisfactory evidence. He recorded several birds that have not since been reported from our state, and some of his specimens are still in the Peabody Museum of Yale University, and others in the collection of the Bridgeport Scientific Society.

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[1] A Catalogue of Birds of Connecticut, arranged according to their natural families; by the Rev. James H. Linsley. *Am. Jour. Sci. and Arts*, vol. xliv, No. 2, pp. 249-74, April, 1843.

[2] Merriam, Review of the Birds of Connecticut, p. 144.

Thirty-four years later Dr. C. Hart Merriam prepared a list with copious and valuable annotations, which was published in the Transactions of the Connecticut Academy of Arts and Science in 1877.[1] This work is a model of its kind, but has been long out of print. Dr. Merriam was able to notice 291 species with good claims to inclusion in our avifauna; and of these several have not been taken since in our state.

Thirty-four years have again passed, during which enormous strides have been taken in the knowledge of the birds of our entire country. We wish we could say the knowledge of Connecticut ornithology had kept pace. But it has not. The birds of certain localities near the larger cities are well known, but there are still large districts — in fact the greater portion — of the state from which no records have reached us. Ornithologists in Connecticut are far too few, and many of them have little time to devote to this study; but all have responded most generously to our appeal for assistance, as the following pages will show. This list is based primarily on the notes and collections of Mr. Sage and Dr. Bishop, obtained through field work in Connecticut during the past 45 and 30 years respectively. The migration dates for Portland and New Haven, given without quotation of authority, are taken from their field notes, as are all other statements and dates for which the name of the authority is not cited. Practically all the other records from the western portion of the state and from New London were given to Dr. Bishop, either in the form of specimens, by notes, or by word of mouth, by the gentlemen to whom they are accredited; and he is entirely responsible for the chapter on Economic Ornithology. For the citation of most of the other published and unpublished records Mr. Sage is to be credited, while Mr. Bliss has found some in ornithological literature. To Mr. Bliss has fallen the task of tabulating Mr. Sage's records of the past 45 years, which press of other duties prevented Mr. Sage doing himself, searching ornithological works for records, preparing much of the bibliography, as well as the index, etc., and combining all the notes into as harmonious a whole as is possible in a work of this character.

For cordial cooperation and assistance our hearty thanks are due to Prof. A. E. Verrill, Dr. Leonard C. Sanford, Rev. Herbert K. Job, Harry W. Flint, J. B. Robertson, Clarence R. Hooker, Aretas A. Saunders, Clifford H. and Dwight B. Pangburn, Philip L. Buttrick, and Alfred W. Honywill, Jr., of New Haven; Lewis B. Woodruff and Prof. C. C. Trowbridge, of New York; William H. Hoyt, Louis H. Porter, and John Schaler, of Stamford; Dr. E. H. Eames, Henry W. Beers, and George L. Hamlin, of Bridgeport; Jesse C. A. Meeker, of Danbury; E. H. Austin, of Gaylordsville; H. Cornelius and Robert C. Judd, of Bethel; James H. Hill, of New London; Alanson Ganung, of West Haven; Willard E. Treat, of East Hartford; C. G. Hart, of East Berlin; and many others; who have contributed records of value. Mr. Walter R. Nichols, often mentioned in Dr. Merriam's catalogue, also gave his ready help, but him our thanks can no longer reach; and the same is true of the late Mr. E. Seymour Woodruff, whose initials appear so frequently in the following pages. A careful and conscientious observer, with wonderfully keen eyes and ears, an enthusiastic and able naturalist, a firm friend and a delightful companion, he was taken at the beginning of a most promising career, leaving all who knew him to mourn him. We wish also to add our tribute to the faithfulness and reliability of Judge John N. Clark, who died in 1903, and whose letters and published records are often quoted in this Bulletin. A thorough and painstaking ornithologist, he did more perhaps than any one else to increase our knowledge of the breeding habits of certain birds along the southern border of Connecticut.

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[1] Review of the Birds of Connecticut with Remarks on their Habits, by C. Hart Merriam. *Trans. Conn. Acad.*, vol. iv, pp. 1-150, July, 1877.

That this list is in many ways unsatisfactory and incomplete the authors realize all too well; but they hope that it may be a stimulus to others to fill up the gaps by conscientious collecting, never being satisfied with an "opera-glass record" of any species that is at all rare, or with which they are not perfectly familiar. Field-glasses are of great assistance in the study of the habits of birds, and in identifying species with which one is already familiar; but every field ornithologist knows that the play of light and shadow often distorts colors and size so that the bird in the hand may prove a very different species from what it appeared in the tree. Therefore records of species out of their accustomed habitat should always be received with doubt unless accompanied by the bird itself. No one need fear that such collecting will prevent a species from establishing itself in our state; for experience has shown that birds have their natural limits, within which alone they can rear young successfully, and that the reason any given species of North American bird does not nest with us is that for some cause it finds the conditions in the season of reproduction unfavorable, or that it is unable to survive our winters, *unless it is destroyed for sport or millinery.* The vain attempts of the Carolina Wren to obtain a foothold in southern Connecticut are a case in point. Practically all our exact knowledge of the usefulness of birds has been obtained by the labor of ornithologists, often undertaken without thought of pecuniary reward; and it seems the height of ingratitude and folly to impede their future work by the imposition of burdensome regulations regarding collecting, or to forbid collecting entirely, as has been done by some legislatures. For, if there is one thing that is evident to those who have done much field work in ornithology, it is that the collecting of birds and eggs for scientific purposes, even by boys, can never appreciably reduce their numbers, as long as they are protected from too much slaughter in the name of sport, and their eggs and young are guarded from cats, which probably do as much damage to the young of our small useful birds near our towns and cities as all other agencies combined.

# PART I

# Catalogue

OF THE

# Birds of Connecticut

# Catalogue of the Birds of Connecticut.

## Order PYGOPODES. Diving Birds.

### Suborder COLYMBI. Grebes.

### Family COLYMBIDÆ. Grebes.

**Colymbus holbœlli** (Reinhardt). Holbœll's Grebe.

A rare winter resident of Long Island Sound from November to March; very rare inland.

Earliest record. Portland, Oct. 30, 1895.

Latest record. Portland, May 3, 1889.

Connecticut records. Linsley recorded this species from Stratford;[1] Oct. 19, 1860, Hartford, one shot (reported by Dr. Crary);[1] Feb. 23, 1875, Saybrook, one taken (J. H. S.); Feb. 21, 1885, New Haven (G. E. V., in Peabody Museum); spring, 1887 (?), Milford, one taken (in coll. of L. C. S.); May 3, 1889, one; April 14, 1894, one; Oct. 30, 1895, one, Portland (in coll. of J. H. S.); Nov. 16, 1895, Stony Creek, female taken (E. M. Cooper, in coll. of L. B. B.); Feb. 20, 1899, Bridgeport, young male taken (J. H. Canfield, in coll. of Mr. Beers); Feb. 27, 1902, Saybrook, one taken (J. N. C.); Jan., 1904, New Haven (in coll. of L. C. S.); April, 1904, Kent, one shot (recorded by H. K. J.);[2] Jan. 26, 1905, Danbury, one picked up exhausted and kept some time (Bristol, recorded by J. C. A. M., now in coll. of L. B. B.); Feb. 6, 1908, Gaylordsville, one found alive (G. A. Clute, in coll. of L. B. B.); Dec. 28, 1909, one; Oct. 15, 1910, Portland, one (in coll. of J. H. S.).

**Colymbus auritus** Linnæus. Horned Grebe.

Formerly a common fall migrant and winter resident on Long Island Sound from October to May;[1] much rarer in recent years. Never common in the interior of the state.

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[1] Merriam, Birds of Conn., p. 137.

[2] Job, The Sport of Bird Study, p. 288.

Earliest record. New Haven, Sept. 12, 1882; Portland, Oct. 19, 1877.

Latest record. New Haven, March 16, 1894; Portland, May 3, 1889.

Recent records. Nov. 6, 1905, Sept. 28, 1906, Litchfield (E. S. W.); Nov. 3, 1906, Guilford (L. B. B.); Oct. 6, and Nov. 9, 1906, Stony Creek (L. B. B.); May, 1906, Litchfield (H. K. J.);[1] Oct. 21, 1907, New Haven (A. A. S.); Feb. 25, 1909, Portland (J. H. S.).

Breeding records. Mr. Job believes a pair bred in Litchfield County in 1906. The following specimens in breeding plumage are recorded for this state: North Haven, April 24, 1883; New Haven, May, 1888 (L. C. S.); Portland, May 3, 1889 (in coll. of J. H. S.); Stamford, May 8, 1893 (in coll. of Mr. Porter).

The Horned Grebe has been recorded from the following inland localities: Haddam (J. H. S.); Litchfield (E. S. W. and H. K. J.); Melrose (C. A. Thompson);[2] Portland (J. H. S.); East Hartford (W. E. T.).

**Podilymbus podiceps** (Linnæus). Pied-billed Grebe.

A common fall migrant in September and October on fresh-water ponds and on the creeks of the tide-water marshes. Very rare in the spring.

Average fall migration. Sept. 15 — Oct. 20.

Earliest record. New Haven, Aug. 30, 1895; Portland, Sept. 10, 1893.

Latest record. New Haven, Oct. 25, 1882; Portland, Nov. 22, 1893.

Spring records. April 7, 1892, Stratford (C. K. A., in coll. of Bpt. Sci. Soc.); April 13, 1895, and April 19, 1905, Portland (J. H. S.); April 12-14, 1906, New Haven (A. A. S.); April 2-23, 1910, West Haven (H. K. J.); May 6, 1910, West Haven (L. B. B.).

Breeding records. E. H. A. informs us that he has seen this bird almost every month in the year on the ponds in Litchfield County, and believes that they breed there. Mr. N. D. Betts of Boulder, Colo., records[3] seeing five adults on a pond in Wilton,

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[1] Job, The Sport of Bird Study, p. 287.

[2] *O. and O.*, viii, 1, p. 3.

[3] *Bird-Lore,* xii, 5, p. 199.

Conn., July 21, 1909, one of which was feeding four young. These young did not appear to be over five or six inches long, and must have been hatched at the pond. Merriam[1] and Samuels[2] both note that this species breeds within the state, though neither mentions any specific records.

### Suborder CEPPHI. Loons and Auks.

### Family GAVIIDÆ. Loons.

**Gavia immer** (Brünnich). Loon. Great Northern Diver.

A common winter resident of Long Island Sound from November to May, the majority going farther south in the winter. Occasional on the inland waterways. Very rare in the summer.

Earliest record. New Haven, Nov. 10, 1883; Portland, Sept. 26, 1892.

Latest record. New Haven, May 24, 1900, and 1907 (C. H. P.); Portland, July 6, 1893.

Inland records. Portland, Dec. 1, 1874, Dec. 2, 1877, Nov. 7, 1890, Sept. 26, 1892, July 6, 1893; Litchfield, Nov. 6, 1905, and Sept. 28, 1906 (E. S. W.); Lake Waramaug, Litchfield County (no date given);[3] East Hampton.[4]

Breeding records. Merriam notes[4] that according to Mr. W. G. Buell this species "has been known to breed on a pond at East Hampton." Mr. W. R. Nichols informs us that a pair bred at Lake Saltonstall in 1890, since he saw the old birds with two young there the last of June or early in July of that year, and that the last previous record of their breeding on this lake was in 1878.

Summer records. July 24, 1882, Goose Island, Long Island Sound, one pair (L. B. B.); July 6, 1893, Portland, one young female (J. H. S.).

**Gavia stellata** (Pontoppidan). Red-throated Loon.

A rather common winter resident along the coast from November to March. Very rare inland.

Earliest record. New Haven, Oct. 20, 1883; Portland, Oct. 10, 1892; Branford, Oct. 7, 1908, an adult in summer plumage (L. C. S.).

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[1] Merriam, Birds of Conn., p. 137.

[2] Samuels, Birds of New England, p. 563.

[3] *O. and O.*, ix, 6, p. 76.

[4] Merriam, Birds of Conn., p. 136.

Latest record. New Haven, April 23, 1887 (L. B. W.); Branford, April 30, 1888 (W. H. Gardner).

Inland records. Portland, Oct. 10, 1892, a young female (in coll. of J. H. S.); Hartford, Nov. 20, 1895, a young bird found alive on the street, probably after being caught in the electric wires in the fog.

Only rarely are birds taken in the full nuptial plumage, as most go north in March before assuming this dress.

Mr. Nichols informed Mr. Merriam[1] "that he saw one as late as June 2, 1877."

### Family ALCIDÆ. Auks, Murres, and Puffins.

### Subfamily ÆTHIINÆ. Auklets, Murrelets, and Guillemots.

**Cepphus grylle** (Linnæus). Black Guillemot.

The only record for this species in Connecticut is that of a male, received by J. H. S. from Mr. Gurdon Trumbull, taken at Stony Creek in December, 1887.[2]

### Subfamily ALCINÆ. Auks and Murres.

**Uria lomvia lomvia** (Linnæus). Brünnich's Murre.

An irregular and probably accidental winter visitor to Long Island Sound; found occasionally on the ponds in the interior of the state.

Usual visitation between Dec. 1 and Jan. 15.

Earliest record. Portland, Nov. 21, 1901; Rocky Hill, Nov. 18, 1893 (W. E. T.).

Latest record. Saybrook, Feb. 19, 1878 (J. N. C.).

Records for Connecticut. Feb. 19, 1878, Saybrook (J. N. C.); Jan., 1884, Saybrook (Dr. Pratt); Jan. 7, 19, 1891, Stamford (Hoyt and Schaler); Jan. 13, 1891, common at Stony Creek (W. F. Davis); Nov. 18, 1893, Rocky Hill (W. E. T.);[3] Dec. 11, 1894, Essex (E. Saunders); Dec. 14, 22, 1894, Portland (J. H. S.); Dec. 15, 1894, Stamford (Hoyt); Dec. 1894, Lake Saltonstall (A. J. G.); Jan. 1, 1895, Stony Creek (E. M. Cooper); Dec., 1896, New Haven (L. C. S.); winter, 1900-1, Saybrook (J. N. C.); Nov. 21, 29, Dec. 14, 1901, Portland (J. H. S.); Dec. 6,

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[1] Merriam, Birds of Conn., p. 136.

[2] J. H. S., *Auk*, vii, 3, p. 283.

[3] *Auk*, xii. 2, p. 177.

1901, New Haven (C. A. Dorman); Dec., 1901, Still River, Litchfield County (H. K. J.); Dec., 1907, Twin Lakes (C. S. Phelps).[1]

According to C. K. A.[2] this species occurred in great numbers along the Connecticut coast during the winter of 1890-1. Hoyt (Stamford) reported them plentiful there from Dec. 20 to Feb. 10 of that winter, he himself seeing fourteen. At that same time D. C. Sanford reported "thousands of them" in the vicinity of the mouth of the Saugatuck River.

The Murre taken by Capt. Brooks near Faulkner's Island "about eight years ago" and recorded by Dr. Merriam as *Uria troile* is a bird of this species.[3]

This species was not recorded in Linsley's or Merriam's list.

**Alca torda** Linnæus. Razor-billed Auk.

The only Connecticut reference to this species is by Merriam, who merely states that it is "a rare winter visitor in the Sound".[3]

Specimens have since been recorded from points farther south (Cobb's Island and Norfolk, Va.).

### Subfamily ALLINÆ. Dovekies.

**Alle alle** (Linnæus). Dovekie. Little Auk.

A rare winter visitant on the coast. Very rare inland.

Coast records. Nov. 25, 1874, Saybrook, picked up on beach after a severe storm (in coll. of J. H. S.); Nov. 26, 1877, Morris Cove, New Haven (in Peabody Museum); Oct., 1879, two, Guilford (in Peabody Museum); Jan. 15, 1891, Stony Creek (in coll. of J. H. S.); Feb. 16, 1894, Stony Creek (in coll. of Mr. Porter); *c.* Dec. 10, 1893, Stonington.[4]

Inland records. Nov. 10, 1849, Portland (Wood);[3] Nov., 1871, Middletown (G. B. Goode);[3] Sept., 1874, Wallingford (W. F. Lane);[3] Dec. 7, 1877, Portland (W. W. C.); Nov. 23, 1878, Pomfret, blown inland during severe gale (in coll. of C. M. Jones).[5]

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[1] Job, The Sport of Bird Study, p. 289.

[2] C. K. Averill, *Auk*, viii, 3, pp. 307-8.

[3] Merriam, Birds of Conn., p. 138.

[4] *N. Y. Tribune*, Dec. 10, 1893.

[5] *O. and O.*, viii, 4, p. 32.

## Order **LONGIPENNES.** Long-winged Swimmers.

### Family STERCORARIIDÆ. Skuas and Jaegers.

**Stercorarius parasiticus** (Linnæus). Parasitic (or Richardson's) Jaeger.

Merriam refers to this species as a "rare winter visitor."[1] Linsley notes it from Bridgeport.

Taken at Portland, fall of 1875 (J. H. S.); at Noank, Sept. 10, 1903 (Dr. C. B. Graves, in coll. of J. H. S.).

**Stercorarius longicaudus** Vieillot. Long-tailed Jaeger.

The only record of this species appears in Merriam's Birds of Connecticut, p. 131. "I have just received from Wm. F. Lane, a beautiful adult specimen of this Larine plunderer, which he shot on the Community Lake at Wallingford, Conn., Aug. 30th, 1873."

### Family LARIDÆ. Gulls and Terns.

#### Subfamily LARINÆ. Gulls.

**Rissa tridactyla tridactyla** (Linnæus). Kittiwake.

A very rare winter visitant on the coast.

April 2, 1880, large numbers in the Thames River, Norwich (S. T. H.);[2] Nov. 15, 1883, one brought to the Peabody Museum and seen in the flesh by L. B. B.; Dec. 3, 1884, one seen alive at West Haven by L. B. B.; Dec. 11, 1886, and March 19, 1887, seen at New Haven by L. B. W.; Jan. 21, 1895, a young male taken at Stamford (in coll. of Mr. Schaler).

**Larus leucopterus** Faber. Iceland Gull.

The only record for Connecticut is a young male which was shot by a fisherman between Rye and Stamford, March 3, 1894, and is now in the collection of L. H. Porter.[3]

**Larus kumlieni** Brewster. Kumlien's Gull.

A young female in the collection of Mr. Porter was shot in Stamford Harbor, Feb. 16, 1894.

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[1] Merriam, Birds of Conn., p. 131.

[2] *O. and O.*, vi, 4, p. 31.

[3] *Auk*, xii, 1, p. 76.

**Larus marinus** Linnæus. Great Black-backed Gull.

A rather rare and very shy winter resident of the Sound.

Earliest record. New Haven, Nov. 10, 1883, Oct. 11, 1886 (L. B. W.).

Latest record. New Haven, Jan. 19, 1895, April 2, 1887 (L. B. W.).

**Larus argentatus** Pontoppidan. Herring Gull.

An abundant winter resident on the Sound and along the inland waterways.

Earliest record. New Haven, Aug. 14, 1883; Portland, Oct. 6, 1892.

Latest record. New Haven, May 24, 1900; Portland, April 20, 1908.

During the day these birds are abundant in New Haven Harbor, but the majority do not sleep there, for they may be seen flying west along the coast toward sunset and returning from that direction about sunrise.

Small flocks may often be seen during the migration in May flying high in an easterly direction and at some distance inland. A large flight, estimated at over 1,000 birds, in flocks of from three to twelve individuals, was seen at Hartford, March 20, 1889, by W. E. Treat.

**Larus delawarensis** Ord. Ring-billed Gull.

A rare fall migrant on the coast.

Connecticut records. Nov. 29, 1886, West Haven (L. B. W.); Oct. 19, 1893, Stamford (in coll. of Mr. Porter); Dec. 6, 1893, Stamford (in coll. of Mr. Schaler); Dec. 4, 1896, Stony Creek (J. E. Cooper, in coll. of L. B. B.); Oct. 23, 1905, Oct. 7, 1908, Branford (L. C. S., the latter in coll. of L. B. B.).

Merriam asserts that it is not rare and that the young of this species may frequently be seen in the winter associated with *L. argentatus*.[1]

**Larus atricilla** Linnæus. Laughing Gull.

At present only an accidental summer visitor. Never common.

Linsley found it at Stonington. Mr. Osborne informed Dr. Merriam that he had seen one, June 1, 1876.[1]

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[1] Merriam, Birds of Conn., p. 132.

The only recent record is that of L. C. S., who saw an adult in breeding plumage, followed by a young bird, at Branford, Sept. 1, 1904.

**Larus philadelphia** (Ord). Bonaparte's Gull.

A rather rare late fall migrant and occasional winter resident on the Sound. Rare inland.

Earliest record. New Haven, Nov. 10, 1883, Oct. 11, 1889 (L. B. W.); Stamford, Sept. 15, 1904 (Schaler).

Latest record. New Haven, Dec. 29, 1884, Jan., 1887 (E. F. Coe).

Inland records. Litchfield, July 1, 1892 (examined by L. B. W. and E. S. W.); Sept. 24, 1895, four (E. S. W.); April, 1905 (in coll. of Litchfield Sci. Soc.);[1] Haddam Neck, Nov. 17, 1900 (in coll. of J. H. S.); Wallingford, fall, 1874 (eight seen by W. F. Lane).[2]

Summer records. Litchfield, July 1, 1892;[1] Saybrook, Aug. 8, 1896 (A. Taylor, in coll. of J. H. S.).

Formerly "quite common about Faulkner's Island, Conn., in October and November" and occasionally seen "at Goose Island in the summer".[2]

### Subfamily STERNINÆ. Terns.

**Sterna hirundo** Linnæus. Common Tern.

A rather rare though formerly common[3] summer resident, breeding in a few small colonies on islands in the Sound and in the extensive salt marshes of the eastern part of the state.

Breeding sites. Prior to 1898, when the Government took over Great Gull Island on Long Island Sound for coast defense fortifications, this island was the location of a colony of 7000 terns. Since their dispersion at this time they have taken all the available islands off the Connecticut shore for nesting sites, where from one to a dozen pairs may be found every season. These include Goose I. (near Faulkner's I.), Duck I. (near Saybrook), Goose Rock (south of Niantic), Waterford I. (Niantic Bay), Two Tree I. (Millstone Point), Liddy's I. and Rocky I. (near Stonington) (Hill). A few formerly bred on Goose Island.[3]

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[1] Job, The Sport of Bird Study, p. 289.

[2] Merriam, Birds of Conn., pp. 132-3.

[3] Merriam, Birds of Conn., p. 133.

On the mainland also this species occasionally breeds. L. B. B. found about twenty-five pairs breeding on the salt marshes at the mouth of the Hammonasset River, Clinton, June 23, 1904. Another colony of a dozen pairs was found at Grove Beach, Clinton, June 16, 1900, by Messrs. J. B. Canfield and C. H. Watrous.

Nest. The eggs are either laid on the sand of the beach or in hollows in the drift seaweed lying on the wet salt marsh.

Eggs, 2 to 5; average set, 3.

Nesting dates. Earliest record, May 25, 1900, three eggs (Hill). Latest record, July 24, 1882, one egg (L. B. B.).

In the fall migration this tern is occasionally common in the western part of the Sound. Mr. Hoyt reported them abundant at Stamford in August, 1894. L. B. B. saw them in West Haven as late as Sept. 20, 1889, and Sept. 27, 1901.

**Sterna paradisæa** Brünnich. Arctic Tern.

In 1876 Merriam recorded the Arctic Tern as "a rare visitor to our shores". The only specific reference to its occurrence in Connecticut is from J. N. C. of Saybrook, who wrote: "I have an undoubted specimen in the fall plumage of the young, taken here last season — never captured a mature bird."[1]

**Sterna dougalli** Montagu. Roseate Tern.

Formerly an abundant summer resident. At present, very rare.

On Goose Island, about one mile from Faulkner's Island, a colony of several hundreds of these birds was carefully protected by Capt. O. N. Brooks, the keeper of the Faulkner Light, until he resigned in 1883. It is of this colony that Merriam writes: "They cover the rocks, almost hiding them from view. . . . The eggs were now hatching and thousands of downy young covered the island."[2] This colony was visited by L. B. B. in the summer of 1881, 1882, and 1883, when many eggs were found and numerous birds seen, but in 1884 not a bird was to be seen and the ground was strewn with fresh or broken eggs. Practically the entire colony had been killed by a taxidermist soon after the birds had settled there for the summer. A few returned to the island the following year, when L. B. B. found one nest with two eggs and four with one egg each, but these terns are no longer common anywhere along the coast. The last record is a set of five eggs from Goose Island in 1888.

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[1] Merriam, Birds of Conn., p. 133.

[2] Merriam, Birds of Conn., pp. 133-4.

According to Hill, a few still breed with the Common Terns on the different islands, though he has not identified any eggs as positively belonging to this species.

The Roseate Tern was formerly common also in Stamford Harbor, though it is not found there now (Hoyt).

**Sterna antillarum** (Lesson). Least Tern.

Formerly common in certain localities along the coast. No recent records.

J. N. C. reported them as quite abundant at Saybrook during migrations.[1] (This was prior to 1876.) Linsley took it at Stratford.[1] They were also formerly common at Stamford Harbor according to Hoyt, but never occur there at present.

**Sterna fuscata** Linnæus. Sooty Tern.

The following records appear from Connecticut: 1876, Saybrook, picked up stunned by concussion with a wharf depot (in coll. of J. N. C.);[2] Sept., 1876, two adults killed themselves by flying against the Faulkner Light (one in coll. of Capt. Brooks);[2] summer, 1876, specimen killed with a stone by Mr. E. Coe, Stony Creek;[2] Sept. 20, 1876, specimen taken at Granby;[2] Sept. 16, 1878, a young male knocked down with an oar in Stamford Harbor (in coll. of Mr. Porter);[3] Oct., 1891, one found dead in the woods at Torrington after a severe storm.[4]

**Hydrochelidon nigra surinamensis** (Gmelin). Black Tern.

A rare visitor, usually late in August.

Connecticut records. Aug. 25, 1891, Stamford, a young female (in coll. of Mr. Porter); Aug. 29, 1892, Little River Marshes, Middletown, four, one secured (in coll. of J. H. S.); Aug. 24, 1893, Milford, two shot;[5] Aug. 29, 1893, Quinnipiac Marshes,

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[1] Merriam, Birds of Conn., p. 134.

[2] Merriam, Birds of Conn., pp. 134-5.

[3] *Auk*, xii, 1, p. 86.

[4] Job, The Sport of Bird Study, p. 289.

[5] *Forest & Stream*, xli, p. 250.

New Haven, a flock of between thirty and forty, probably driven from their course by a southeast gale (L. B. B.); fall, 1899 (?), Old Park Pond, Winsted,[1] one seen; Sept. 6, 1909, Hammonasset Marshes, Clinton, one young shot (C. R. Hooker, in coll. of L. B. B.). Dr. Merriam records it as a rare visitor, noting but two specimens, one taken near Goose Island by Capt. Brooks (about 1864), another shot late in August at Milford.[2]

### Family RYNCHOPIDÆ. Skimmers.

**Rynchops nigra** Linnæus. Black Skimmer.

One was taken near the Yale boat-house in New Haven Harbor about June 16, 1883, and was identified, June 18, by L. B. B. Judge John N. Clark wrote J. H. S., Nov. 8, 1894: "A Black Skimmer was killed here (Saybrook) a few days ago."

## Order **TUBINARES.** Tube-nosed Swimmers.

### Family PROCELLARIIDÆ. Fulmars, Shearwaters, and Petrels.

#### Subfamily Fulmarinæ. Fulmars.

**Fulmarus glacialis glacialis** (Linnæus). Fulmar.

A single bird of this species was shot by A. H. V. at the Thimble Islands, Stony Creek, Oct. 10, 1909, and brought to L. C. S. in the flesh. It is now in the collection of L. C. S. This is the only record for Connecticut, except the doubtful reference in Linsley's list, of which Merriam does not consider he had sufficient proof.[3]

#### Subfamily Puffininæ. Shearwaters and Petrels.

**Puffinus gravis** (O'Reilly). Greater Shearwater.

According to Merriam (1876), "not rare in winter off the coast, but generally keeps outside the Sound." Linsley recorded it as common about Stonington. Merriam further notes that "in the Museum of Wesleyan University at Middletown is the head of a bird of this species which is said to have been killed at Granby, Conn."[4]

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[1] Job, The Sport of Bird Study, p. 290.
[2] Merriam, Birds of Conn., p. 135.
[3] Merriam, Birds of Conn., p. 146.
[4] Merriam, Birds of Conn., p. 136.

### Subfamily PROCELLARIINÆ. Storm Petrels.

**Oceanodroma leucorhoa** (Vieillot). Leach's Petrel.

Pelagic. Rarely seen within the limits of this state.

Connecticut records. Oct. 27, 1857, one shot by Geo. Meigs on the Connecticut River above Hartford;[1] Merriam also records (1876) that he himself has "twice seen it on the Sound in the vicinity of Faulkner's Island, and near New Haven;" Sept. 17, 1903, a female picked up in Middletown, driven inland by a terrific storm; Oct. 18, 1904, a specimen killed in Portland (both the latter in coll. of J. H. S.); Oct., 1904, one taken by Mr. James Truelove on Lake Wononscopomus, Lakeville (in coll. of L. B. B.). Mr. Wm. Hansen reports seeing a mounted bird which was found dead in Torrington, Sept., 1902.[2]

### Subfamily OCEANITINÆ. Long-legged Storm Petrels.

**Oceanites oceanicus** (Kuhl). Wilson's Petrel.

We have no specific records of this species. Merriam characterizes it as "not common; occurs off the coast in summer."[3] Linsley says that he has seen this species "not only in our Sound, but even west of Stratford."[3] Mr. Holt of Lyme told W. E. T. that this species "occasionally flies over land and is usually seen hovering over fern bushes" (J. H. S.).

About a dozen petrels, almost certainly of this species, were seen in Long Island Sound not far from the mouth of New Haven Harbor, Aug. 5, 1911, by L. B. B.; and to this species should probably be referred three petrels seen by Mr. Edward Everit near Branford Beacon, June 20, 1909.

## Order STEGANOPODES. Totipalmate Swimmers.

### Family SULIDÆ. Gannets.

**Sula leucogastra** (Boddaert). Booby.

The only record of this species in Connecticut is one taken at Guilford by Linsley.[4] Merriam refers to it as "a rare and accidental visitor from the South."

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[1] Merriam, Birds of Conn., pp. 135-6.

[2] Job, The Sport of Bird Study, p. 290.

[3] Merriam, Birds of Conn., p. 136.

[4] Merriam, Birds of Conn., p. 130.

**Sula bassana** (Linnæus). Gannet.

A very rare winter visitant. The following references are found in Merriam:[1] Capt. Brooks of Faulkner's Island has seen two of this species, one of which "was killed at Guilford in the spring about ten years ago" (i. e., about 1866), and is now in his collection. Linsley took it at Stratford (now in Peabody Museum). Both these birds are in juvenile plumage. Mr. Robert Morris saw an adult specimen shot off Branford late in the fall of 1872 or 1873.

### Family PHALACROCORACIDÆ. Cormorants.

**Phalacrocorax carbo** (Linnæus). Cormorant.

A very rare fall migrant on the Sound. Formerly a "tolerably common winter visitant."[2]

Capt. Brooks wrote Merriam that they were plentiful in April and May, and were sometimes seen in the fall. Linsley took this species at Stonington.

The only recent record is that of a young bird shot at Branford, Nov. 22, 1904. It is now in the collection of L. C. S.

**Phalacrocorax auritus auritus** (Lesson). Double-crested Cormorant.

A rare spring and fall migrant on the Sound, though apparently more common than *P. carbo;* very rare inland.

Spring records. Linsley records a specimen from Stratford which is in nuptial plumage (in coll. of Bridgeport Hist. Soc.); May, 1876, Capt. Brooks saw "large flocks of them feeding about Faulkner's Island";[2] April 30, 1888, one taken at Branford by W. H. Gardner (now in Peabody Museum); June 8, 1892, three seen at the mouth of Connecticut River by J. H. S.; April 29, 1896, one from a flock of six taken at New Haven (seen in the flesh by L. B. B.); May 7, 1891, Guilford (H. W. F., now in coll. of Wm. Brewster).

Fall records. Oct. 29, 1875, one killed in Connecticut River at Portland (in coll. of W. W. C.); Oct., 1879, one shot at Bolton (in coll. of W. W.); Nov. 10, 1883, a small flock seen off Guilford by L. B. B.; Oct. 23, 1890, one adult seen at Little River Marshes, Middletown, by W. E. T. and S. R.; Nov. 2, 1890, one seen at Hartford by W. E. T.; Sept. 25, 1904, a flock seen on the beacon in Branford Harbor by G. E. V.; Oct. 17, 1908, a young male shot at Double Beach, Branford, by C. R. Hooker (in coll. of L. B. B.).

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[1] Merriam, Birds of Conn., p. 129.

[2] Merriam, Birds of Conn., p. 130.

Summer record. July 18, 1906, Madison, two seen (A. A. S.).

Inland records. Portland, Oct. 29, 1875 (see above); Bolton, Oct., 1879 (see above); Middletown, Oct. 23, 1890 (see above); Hartford, Nov. 2, 1890 (see above).

### Family PELECANIDÆ. Pelicans.

**Pelecanus occidentalis** Linnæus. Brown Pelican.

The only record of the Brown Pelican in Connecticut is that of an apparently uninjured specimen caught alive off Guilford Harbor, June 6, 1902, by Mr. Levi Thrall, who reported that it seemed unable to fly far, so that he easily caught it by chasing it in a rowboat. L. B. B. saw it in the flesh. It is at present in the collection of L. C. S.

### Family FREGATIDÆ. Man-o'-war-birds.

**Fregata aquila** (Linnæus). Man-o'-war-bird.

The only record of this species in Connecticut (noted both in the *American Naturalist* and in Merriam's Birds of Connecticut),[1] is that of Capt. Brooks, who killed a female on Faulkner's Island in the autumn of 1859, while it was hovering over the island. It is still in the collection of Capt. Brooks (L. B. B.).

## Order ANSERES. Lamellirostral Swimmers.

### Family ANATIDÆ. Ducks, Geese, and Swans.

### Subfamily MERGINÆ. Mergansers.

**Mergus americanus** Cassin. Merganser.

A tolerably common winter resident from December to February, frequenting fresh-water lakes and inland waterways.

Earliest record. (Coast) Clinton, Dec. 2, 1898; (Inland) Portland, Dec. 3, 1888.

Latest record. (Coast) Stamford, Feb. 25, 1898; (Inland) Portland, April 23, 1904. (J. H. S. records this species at Portland as late as April, in 1875, 1887, 1899, 1904, and 1909.)

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[1] Merriam, Birds of Conn., p. 131.

Unusual records. June 26, 1888, Portland (J. L. Goff); July 31, 1879, Portland (J. H. S.).

H. K. J. reports the Merganser as a fairly common migrant and winter resident in Litchfield County between November and April.[1]

**Mergus serrator** Linnæus. Red-breasted Merganser.

A rather common winter resident on the Sound from November to March; occasional inland.

Earliest record. New Haven, Oct. 21, 1882.

Latest record. New Haven, April 4, 1895.

Inland record. Portland, Nov. 9, 1884 (in coll. of W. W. C.).

**Lophodytes cucullatus** (Linnæus). Hooded Merganser.

A rare and irregular spring and fall migrant.

Spring migration. Earliest record. Portland, March 6, 1876. Latest record. Portland, April 1, 1899.

Fall migration. Earliest record. Litchfield, Sept. 15, 1905 (L. S. W.). Latest record. Portland, Dec. 5, 1887.

Several specimens of the Hooded Merganser have been shot in the Quinnipiac Marshes (North Haven) and in Lake Saltonstall (East Haven); viz., Jan. 9, 1883, one (L. C. S.); Oct., 1885, three young (L. C. S.); Nov. 14, 1904, two young (A. J. G.); March, 1904, one (A. J. G.); March, 1904, several (Devine); March 20, 1907, two (Uhl); Nov. 11-13, 1908, seven (Haines, in coll. of L. B. B.).

H. K. J. reports that Mr. C. H. Williams "saw a female with young in Winchester about fifteen years ago" (*c.* 1893).[1]

Dr. William Wood of East Windsor Hill wrote in 1880: "It is not common here, yet some seasons I get half a dozen or more, and then several seasons may intervene before another is captured."[2]

There is a male of this species in the collection of J. M. W. shot on a pond in Canterbury late in October, 1880.[3] Mr. J. Y. Stetson of New Haven has an adult male which he shot from a pair at Neversink Lake, Danbury, late in March, about 1885.

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[1] Job, The Sport of Bird Study, p. 290.

[2] *O. and O.*, v, 12, p. 93.

[3] *O. and O.*, v, 10, p. 78.

### Subfamily ANATINÆ. River Ducks.

**Anas platyrhynchos** Linnæus. Mallard.

Formerly a rare fall migrant on the coast, but much more common in recent years; occasionally a winter resident.

Earliest record. New Haven, Oct. 25, 1904.

Latest record. New Haven, Jan., 1897, and 1899 (L. C. S.); Clinton, March 27, 1889 (J. F. Parker).

This species probably occurs regularly on the Quinnipiac Marshes and Lake Saltonstall (where L. B. B. and others have obtained many records), as well as along the Connecticut River.

Merriam[1] characterizes the Mallard as a "rare migrant." He notes their occurrence Sept. 30, Oct., and Nov. 13, 1875, and the observations of Grinnell in October and November, 1876. Mr. Hoyt states one was taken in Stamford in the fall of 1879. C. M. Jones of Eastford records[2] a pair shot in Eastford, Oct. 30, 1882, adding that it "is the first time I have ever known of this species occurring here." The first records for New Haven were November 5, 1883, when L. B. B. reported three taken in the Quinnipiac Marshes, and Aug. 4, 1886, when E. L. Munson[3] took an adult male at the same locality. However, since that time the Mallards have been increasing, so that recent records are quite numerous for this species in Connecticut.

Judge Clark reported an unusual flight at Saybrook in the winter of 1901-2, saying he had seen more that winter than in the rest of his life.

**Anas rubripes** Brewster. Black Duck.

A common fall and tolerably common spring migrant and winter resident; rare summer resident.

Spring migration. Earliest record, Portland, March 10, 1878. Latest record, New Haven, June 27, 1884; Portland, May 11, 1908.

Fall migration. Earliest record, New Haven, Sept. 16, 1904; Portland, Sept. 14, 1877. Latest record, Portland, Nov. 8, 1892.

Winter records. Portland, Dec. 9, 1896, Jan. 2, 1906. Winters at New Haven.

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[1] Merriam, Birds of Conn., p. 123.

[2] *O. and O.*, viii, 4, p. 32.

[3] *O. and O.*, xii, 9, p. 156.

Nest. Eggs laid on bank of a stream, in a meadow, or in a thicket, some distance from the water.

Eggs. Usually 9 (11).

Breeding records. May 12, 1898, nine eggs, and June 8, 1899, nine eggs, New London (Hill); May 20, 1901, eleven eggs, Kent (H. K. J.); April 22, 1904, five eggs, incomplete, Kent (Austin). At Saybrook Judge Clark found two nests of this duck.

Fall migrants reached Litchfield on Sept. 7, 1905 (E. S. W.).

**Chaulelasmus streperus** (Linnæus). Gadwall.

Very rare.

Merriam[1] states that it occurs during migrations, though not common (1876). At that time Capt. Brooks wrote Merriam that these birds were "occasionally seen" about Faulkner's Island. Linsley wrote that "flocks of the Gray Duck were here as early as August last season" (1842). One was shot at East Hartford, Nov. 5, 1883 (W. E. T.).

The only recent records are those of H. K. J., who heard of two being shot at Twin Lakes about the middle of November, 1907,[2] and states that Mr. W. A. Miles has killed others there; and the two young males taken on the Quinnipiac Marshes (North Haven), Oct. 12, 1912, by A. and W. Ganung (in coll. of L. B. B.).

**Mareca americana** (Gmelin). Baldpate.

A rare winter resident on the Sound from October to March.

Earliest record. Quinnipiac Marshes, New Haven, Oct. 11, 1909 (A. Ganung).

Latest record. Clinton, March 27, 1899 (J. F. Parker).

Inland records. Hamden, Oct. 16, 1880 (Woolsey, in coll. of Peabody Museum); Middletown, fall, 1882, five out of a flock of seven killed by J. Taylor (J. H. S.); Portland, April, 1883, a male shot (J. H. S.); Portland, Oct. 23, 1888, a female shot by J. L. Goff (in coll. of J. H. S.); Bantam Lake, Litchfield, one shot Oct. 20, 1904, and another, Oct. 20, 1905, by H. Sanford (E. S. W.).

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[1] Merriam, Birds of Conn., p. 124.

[2] Job, The Sport of Bird Study, p. 291.

Besides these records a number of birds have been taken at Lake Saltonstall and in the Quinnipiac Marshes, the majority of which are in the collections of L. C. S. and L. B. B., in addition to a few birds taken at Branford, Clinton, and Stony Creek.

Merriam[1] mentions this species as "not particularly rare during the migrations." It was taken by Linsley at Stratford, and one by Dr. Wood at East Windsor Hill.

**Nettion crecca** (Linnæus). European Teal.

Very rare in North America. The only Connecticut reference is furnished by W. E. T. of East Hartford, who received from a resident gunner a fine adult male, shot Nov. 14, 1889, while flying with another, apparently of the same species, over an open field. It is now in the collection of J. H. S.[2]

**Nettion carolinense** (Gmelin). Green-winged Teal.

A tolerably common fall and rare spring migrant, and a rare winter resident.

Fall migration. Earliest record. New Haven, Sept. 3, 1886; Portland, Sept. 27, 1903; Litchfield, Sept. 8, 1906 (E. S. W.). Latest record. New Haven, Oct. 16, 1883; Portland, Nov. 27, 1896.

Spring records. April 8, 1874, and April 6, 1887, Portland (J. H. S.); March 21, 1896, Stony Creek (E. M. Cooper, in coll. of L. B. B.); March 8, 1899, Clinton (J. F. Parker, in coll. of L. B. B.); "Have seen it in March" (Merriam).[1]

Winter record. Jan. 14, 1902, one taken in Branford Harbor by Mr. J. Lanfear (in coll. of L. C. S.).

**Querquedula discors** (Linnæus). Blue-winged Teal.

A tolerably common fall and rare spring migrant.

Fall migration. Earliest record. New Haven, Sept. 1, 1886; Portland, Sept. 8, 1897. Latest record. New Haven, Sept. 20, 1896; Portland, Oct. 17, 1874.

Spring records. April 14, 1896, Quinnipiac Marshes (A. R. Andrews, in coll. of L. B. B.); April 9, 1902, Portland; April 27, 1905, West Haven (W. L. Ganung, in coll. of L. B. B.).

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[1] Merriam, Birds of Conn., p. 124.

[2] W. E. Treat, *Auk*, viii, 1, p. 112.

Unusual record. July 26, 1890, Quinnipiac Marshes, seen by Prof. C. C. Trowbridge and L. C. S.

**Spatula clypeata** (Linnæus). Shoveller.

A very rare migrant along the coast.

Connecticut records. March 20, 1854, two full-plumaged males taken at Lyme by Horace Champion (formerly in coll. of J. C. Comstock) (J. H. S.); Dec. 8, 1874, specimen shot by Mr. Pease at Saybrook (in coll. of W. W. C.); Oct. 8, 1875, two or three, near Milford (Grinnell);[1] Oct. 29, 1886, four taken in West Haven (formerly in coll. of L. C. S.); Nov. 27-30, 1893, a flock frequented the Quinnipiac Marshes (A. R. Andrews and E. Mitchell); Oct., 1894, one taken in Stamford (in coll. of Hoyt). Linsley obtained two males at Stratford[1] (in Linsley Coll. of Bpt. Sci. Soc.); has been taken at Twin Lakes (Miles).[2]

**Dafila acuta** (Linnæus). Pintail.

A rare straggler in the fall.

Coast records. Quinnipiac Marshes, one, Sept. 26, 1883 (in coll. of L. B. B.); flock of seven, Sept. 28, 1907 (J. Y. Stetson); two, Oct. 23, 1909 (A. Ganung, in coll. of L. B. B.); West Haven, Oct. 13, 1906, seven seen (A. Ganung, one in coll. of L. B. B.); one, Oct. 22, 1906 (E. S. W.); Stratford, Nov. 10, 1889 (in coll. of Bpt. Sci. Soc.); Stamford, about 1890 (Schaler); Stratford, (Linsley);[3] Saybrook (J. N. C.), not particularly rare (1876).[3]

Inland records. East Windsor Hill, two (in coll. of Dr. Wood, 1876);[3] Portland, Oct. 9, 1890, a young male killed (Parkinson, in coll. of J. H. S.); Middletown, Oct. 12, 1891, four seen, one shot (W. E. T. and S. R., in coll. of J. H. S.); Oct. 18, 1893, four seen by same; Essex, Jan. 22, 1894, fifteen seen, two shot (in coll. of J. H. S.); Torrington, Oct. 25, 1907, one shot (Hanson);[2] Twin Lakes (Miles).[2]

**Aix sponsa** (Linnæus). Wood Duck.

A summer resident, breeding throughout the state but becoming more rare each year.

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[1] Merriam, Birds of Conn., pp. 124-5.

[2] Job, The Sport of Bird Study, p. 291.

[3] Merriam, Birds of Conn., p. 123.

Earliest record. New Haven, March 21, 1884; Portland, March 20, 1879.

Latest record. New Haven, Nov. 17, 1883; Portland, Dec. 3, 1888.

Nest. Usually located in a hollow tree at a height of from eight to thirty feet from the ground.

Eggs. Nine or ten; the last of May.

Nesting dates. Earliest record. May 14, 1900 (H. K. J.). Latest record. July 2, 1904 (J. C. A. M.).

Breeding records. *c.* May 28, 1875, Portland, nest with 14 eggs (J. H. S.); May 24, 1885, Hamden, nest with 9 eggs (R. Morley); June 18, 1891, Chester, a set of 10 eggs (Watrous, in coll. of H. W. F.); May 14, 1900, Kent, 10 eggs in a hay-loft of an old barn (H. K. J.); May, 1901, East Lyme, nest with 9 eggs (Way); July 2, 1904, Litchfield, nest with 10 eggs (J. C. A. M.).

### Subfamily FULIGULINÆ. Sea Ducks.

**Marila americana** (Eyton). Redhead.

A very rare bird until recent years, when it seems to have occurred quite regularly as a winter visitant.

Merriam[1] refers to this bird as "rare," noting that it has been taken at Westbrook (prior to 1876). Linsley took it at Stratford. At Stamford it has been seen frequently in the Sound, and one was taken in the winter of 1886 (W. H. H.). The next record is that of Mr. Holt of Saybrook, who says he shot twenty-eight in 1889, while he later records two or three flocks there, Oct. 19, 1893. Four were taken at Lake Saltonstall, Dec. 20, 1897, by A. J. G., and one at Stratford, Dec., 1897, by J. Locke.

However, since 1902, the species has become more common, and we have records from Branford, Dec., 1901, Jan. 6, Nov. 15, 1902, March, 1904 (L. C. S.), and Jan. 1, 1901 (Locke); Lake Saltonstall, East Haven, Oct. 25, 1902, Dec. 22, 1903 (A. J. G.), April 3, 1907 (A. A. S.); West Haven, April 2, 1910 (H. K. J.); Litchfield, Nov. 3, 6, 1905 (H. Sanford); Portland, Oct. 29, 1903, Oct. 16, 1906, Nov. 26, 1907, Nov. 26, 1909 (J. H. S.).

**Marila valisineria** (Wilson). Canvas-back.

A very rare accidental winter visitor.

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[1] Merriam, Birds of Conn., p. 125.

Connecticut records. 1876, Merriam[1] records this species as "rare"; May 7, 1876, one seen by R. Morris in New Haven (?);[2] J. H. Hand reports it "very rare" at Westbrook, 1876;[1] Linsley took it at Stratford;[1] March 20, 1887, a flock reported seen at Lake Saltonstall by Mr. Folsom; 1889, two reported killed at Saybrook by Mr. Jas. Holt; fall, 1894, one reported taken at Stony Creek by E. M. Cooper (?); Nov., 1896, one shot from a flock at Twin Lakes by W. A. Miles;[2] Jan., 1902, two males taken at Lake Saltonstall by A. J. G. (in coll. of L. C. S.); April 1, 1904, one male taken at North Branford (in coll. of L. C. S.).

**Marila marila** (Linnæus). Scaup Duck.

A common winter resident on the Sound, most abundant in November and March. Rare inland.

Earliest record. New Haven, Sept. 5, 1886.

Latest record. New Haven, May 23, 1902.

Inland records. Portland, Oct. 11, 1888, a young male shot in Connecticut River by J. L. Goff (in coll. of J. H. S.); Portland, Dec. 14, 1888, a female shot by Goff; Litchfield, Nov. 3, 1905, one shot by H. Sanford (E. S. W.).

Unusual date. July 21, 1882, one "pensioner" taken at Stony Creek by L. C. S.

**Marila affinis** (Eyton). Lesser Scaup Duck.

A tolerably common winter resident on the Sound, associating with *M. marila,* and most frequently taken in November and March. Less common inland.

Earliest record. New Haven, Oct. 20, 1902.

Latest record. Unusual date. July 14, 1904, Quinnipiac Marshes, New Haven, a non-breeding adult male in worn plumage taken by L. B. B. New Haven, March 26, 1895.

Inland records. East Hartford, April 26, 1889, Oct. 8, 1888 (W. E. T.); Middletown, Little River Marshes, one seen Oct. 23, 1890, by W. E. T. and S. R., a female seen there also by J. H. S., June 10, 1905, and a male, June 17, 1905; Portland, Job's Pond, one shot July 9, 1895 (in coll. of J. H. S.); Litchfield, Oct.

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[1] Merriam, Birds of Conn., p. 126.

[2] Job, The Sport of Bird Study, p. 292.

19, 1907, one shot (E. S. W.); one killed in the vicinity of East Windsor Hill by Dr. Wm. Wood (no date given).[1]

**Marila collaris** (Donovan). Ring-necked Duck.

A rare accidental winter visitor.

Connecticut records. Merriam[1] records that Linsley took it at Stratford, and also that "G. B. Grinnell has secured several specimens in the vicinity of Milford"; April 10, 1883, East Hartford, adult male shot (W. E. T.); Dec. 19, 1885, New Haven, adult male secured by C. R. Hooker (formerly in coll. of L. C. S.); Oct. 26, 1887, Little River Marshes, Middletown, female shot by Dr. A. K. Fisher in company with J. H. S. (in coll. of J. H. S.); Oct. 3, 1889, East Hartford, female shot (W. E. T.); April 9, 1895, Quinnipiac Marshes, New Haven, adult male taken by R. G. Van Name (in coll. of H. W. F.); Jan. 7, 1898, Lake Saltonstall, young male taken by A. J. G. (in coll. of L. B. B.).

**Clangula clangula americana** Bonaparte. Golden-eye.

A tolerably common winter resident, especially along the coast, from December to March.

Earliest record. New Haven, Nov. 19, 1904, Nov. 17, 1905 (E. S. W.); Portland, Oct. 29, 1898; Litchfield, Oct. 30, 1905 (E. S. W.).

Latest record. New Haven, March 30, 1882, April 12, 1907 (A. A. S.); Portland, April 20, 1888.

**Clangula islandica** (Gmelin). Barrow's Golden-eye.

The only records for this state are: (1) that of A. J. G., who is well acquainted with the American Golden-eye, and who is positive that he took two males of this species at Lake Saltonstall, East Haven, Dec. 25, 1883 (unfortunately these birds were not preserved); (2), a typical male adult specimen in the collection of J. H. S., which was purchased by him in the flesh, Nov. 14, 1867, from a man who said it was killed in the Sound, and whose statement there seems to be no reason for doubting.[2]

**Charitonetta albeola** (Linnæus). Buffle-head.

Formerly an abundant winter resident on the Sound and tidal creeks from December to February; also formerly common inland, especially during March. Now not more than tolerably common.

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[1] Merriam, Birds of Conn., p. 125.

[2] Merriam, Birds of Conn., p. 126.

Earliest record. New Haven, Nov. 26, 1884, Nov. 2, 1888 (L. B. W.); Portland, Oct. 25, 1890; Bantam Lake, Litchfield, Oct. 23, 1905 (E. S. W.); H. Sanford reports them on same date from same locality.[1]

Latest record. New Haven, Feb. 13, 1894, April 10, 1882 (A. H. Baldwin); Portland, April 26, 1887.

Unusual record. July 14, 1858, Lyme, female taken by R. Champion reported in MS. Journal of Jno. C. Comstock (J. H. S.).

**Harelda hyemalis** (Linnæus). Old-squaw.

An abundant winter resident on the Sound from November to April. Less common, if not rather rare, inland.

Earliest record. New Haven, Oct. 24, 1895.

Latest record. New Haven, May 21, 1888.

Inland records. Portland, Nov. 6, 1888, Oct. 15, 1890, March 23, 1894, Oct. 18, 1897, Oct. 14, 1905; Litchfield, Oct. 19, 1907, one taken (E. S. W.).

Summer records. June 17, 1896, an adult male in nuptial dress, prevented from going north by an old fracture of the wing, taken at New Haven by A. R. Andrews (in coll. of L. B. B.); Woodmont, Aug. 2-4, 1906, three seen (A. A. S.).

Breeding record. A pair with young was seen near Little Gull Island at the eastern end of the Sound in the summer of 1886 by L. C. S. Mr. Grinnell in Merriam's Birds of Connecticut[2] notes that they occasionally breed here, though probably these are "pensioners."

**Histrionicus histrionicus** (Linnæus.) Harlequin Duck.

The only record for this state appears in Job, The Sport of Bird Study: "Mr. Williams examined a male (*Histrionicus histrionicus*) in full plumage shot by Matthew Parsons on Old Park Lake, Winsted, in October, seven or eight years ago"[1] (1900 or 1901).

**Camptorhynchus labradorius** (Gmelin). Labrador Duck.

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[1] Job, The Sport of Bird Study, p. 292.

[2] Merriam, Birds of Conn., p. 127.

The only references to this species appear in a paragraph in Merriam: "A very rare winter visitor. Linsley took it at Stratford, Conn. Pennant, in his Arctic Zoölogy, says that this species was 'sent from Connecticut to Mrs. Blackburn in England.' Arctic Zoölogy, vol. ii, p. 559, 1785."[1]

**Somateria dresseri** Sharpe. Eider.

Connecticut records. Linsley states that one or two Eider Ducks were killed at Stratford by Mr. Lucius Curtis.[1] Grinnell informed Merriam that he had seen a specimen killed on the Sound near Milford, May 29, 1877, and that two, probably of this species, were shot there in the fall of 1874.[1] Branford, Dec. 2, 1879, two shot, one in coll. of Dr. Fred. Sumner Smith of Chester (J. H. S.).

Mr. Alanson Ganung shot a young male, Dec. 20, 1909, off West Haven. It is now in the collection of L. B. B. This is the only recent record for this state.

**Somateria spectabilis** (Linnæus). King Eider.

A rare winter straggler in the Sound.

Connecticut records. Nov. 4, 1883, an adult female taken near Milford by E. L. Munson[2] (now in coll. of L. B. B.); Nov. 17, 1886, one shot at Portland (in coll. of J. H. S.); Oct. 22, 1890, a female found in the bag of some sportsmen at Stony Creek by A. E. V. (now in Peabody Museum); Nov. 11, 1893, one received by J. H. S. from Mr. Henry Noyes of Lyme; Nov., 1900, a female taken near New Haven (in coll. of L. C. S.); winter, 1902-3, a female taken in New Haven Harbor by A. Ganung; Nov. 14, 1904, an adult male positively identified at Branford by L. C. S.; Oct. 26, male, Nov. 14, 1907, female, taken at Stratford (in coll. of L. B. B.); Nov. 2, 1908, two young shot at Stratford; Nov. 4, 1908, a young male shot at New Haven by W. Ganung (in coll. of L. B. B.). Linsley also records obtaining two specimens at Stratford. C. L. Rawson states that a stuffed specimen is in Noank, shot off Groton Long Point in the winter of 1884.[3]

**Oidemia americana** Swainson. Scoter.

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[1] Merriam, Birds of Conn., p. 127.

[2] *O. and O.*, xii, 9, p. 156.

[3] *O. and O.*, x, 5, p. 74.

A rare fall migrant on the Sound; very rare along the inland waterways.

Coast records. Linsley records it from Stratford, and Merriam[1] calls it a "tolerably common winter resident," having seen it as early as Oct. 4, 1876. Oct., 1879, New Haven Harbor, one female collected by Dr. G. Woolsey (in Peabody Museum); April 23, 1889, Stony Creek, one seen (J. H. S.); Oct., 1900, Branford, male taken by L. C. S. (in coll. of L. B. B.); Oct. 22, 1902, Branford, male taken by L. C. S.; Oct. 24, 1906, Stony Creek, young bird shot by A. H. V. (in coll. of L. B. B.); Oct. 4, 1909, West Haven, two males taken by A. Ganung (in coll. of L. B. B.).

Inland records. Oct. 9, 1888, Portland, seventeen of a flock of thirty shot by J. L. Goff (seven in coll. of J. H. S.); Oct. 21, 1890, Portland, flock of twenty-five seen (five in coll. of J. H. S.); Oct. 2, 1893, Portland, one seen by W. E. T.; Oct. 16, 1899, Middletown, two shot (in coll. of J. H. S.); Oct. 19, 1900, Portland, two shot.

Spring record. April 23, 1889, Stony Creek, one seen by J. H. S.

**Oidemia deglandi** Bonaparte. White-winged Scoter.

A common winter resident on the Sound, especially abundant in October and November, March and April. Not usually common inland.

Earliest record. New Haven, Oct. 13, 1883; Portland, Oct. 4, 1895.

Latest record. New Haven, May 21, 1888; Sachem's Head, June 8, 1892 (J. H. S.).

Inland records. Oct. 19, 1881, Eastford, female shot (in coll. of C. M. Jones);[2] Oct. 4, 1895, Portland, about seventy-five seen in Connecticut River by S. R.; Oct. 12, 1895, Portland, adult male shot in Connecticut River (in coll. of J. H. S.); Oct. 16, 1900, Portland, one killed by C. E. Lincoln; Oct. 20, 30, Nov. 3, 6, 1905, Oct. 11, 28, 1907, common at Bantam Lake, Litchfield (E. S. W.).

Unusual record. Aug. 30, 1906, Pine Orchard (A. A. S.).

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[1] Merriam, Birds of Conn., p. 127.

[2] *O. and O.*, viii, 4, p. 32.

**Oidemia perspicillata** (Linnæus). Surf Scoter.

A common winter resident on the Sound, though not as common as *O. deglandi,* except in November. Rare inland.

Earliest record. New Haven, Oct. 13, 1893.

Latest record. New Haven, April 19, 1904; Stony Creek, April 23, 1889 (J. H. S.).

Inland record. Oct. 15, 1890, female shot at Portland by J. L. Goff (in coll. of J. H. S.).

Merriam[1] records one on the Sound as late as June 29, 1877.

**Erismatura jamaicensis** (Gmelin). Ruddy Duck.

Formerly a fairly common fall migrant on the Sound and larger lakes; now rare. Very rare in the spring.

Earliest record. New Haven, Oct. 24, 1885; Oct. 14, 1908 (P. B. Haines).

Latest record. New Haven, Nov. 1, 1882; Portland, Nov. 12, 1889; Litchfield, Dec. 1, 1906 (E. S. W.).

Spring records. March 19, 1889, East Hartford, five seen (W. E. T.); June 5, 1893, Portland, three of a flock of five killed in Connecticut River (in coll. of J. H. S.).

Recent records. Since 1896 we have the following records only: Oct. 25, 1904, North Haven, a young female taken by Mrs. L. A. Farnham (in coll. of L. B. B.); E. S. W. reported them common on Bantam Lake, Litchfield, from Oct. 9 to Nov. 11, 1905, also Nov. 24, 1906, and Oct. 11-28, 1907; E. S. W. shot one, Dec. 1, 1906; Oct. 14, 1908, a young male shot at North Haven by P. B. Haines (in coll. of L. B. B.); April 13, 1906, Lake Saltonstall (A. A. S.); Oct. 5, 1907, Lake Burton (A. A. S.).

### Subfamily ANSERINÆ. Geese.

**Chen hyperboreus nivalis** (J. R. Forster). Greater Snow Goose.

An extremely rare winter visitor.

Connecticut records. Linsley records seven specimens of Snow Geese from Stratford; Merriam[2] reports a specimen in the possession of W. W. C., which had been killed near Saybrook in the fall of 1875; E. H. Austin informs us that three Snow Geese, undoubtedly of this species, spent the winter of 1868-9 at Stratford; Nov. 20, 1884, Portland, one adult male taken (in coll. of J. H. S.); Feb. 3, 1893, L. H. Porter purchased two adults and two young in Fulton Market, New York City, where they had been sent a few days before from Stratford.

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[1] Merriam, Birds of Conn., p. 128.

[2] Merriam, Birds of Conn., p. 121.

On the death of Dr. W. H. Hotchkiss of New Haven in 1907, there was found among his effects the head of an adult male of this species, mounted. Dr. H. had previously informed L. B. B. that all of his collection had been taken in Connecticut about 1878, so that this Snow Goose was in all probability killed in this state.

**Branta canadensis canadensis** (Linnæus). Canada Goose.

A common late fall and early spring migrant. Winters rarely.

Fall migration. Average, Oct. 15 — Dec. 15. Earliest record. New Haven, Sept. 11, 1883; Portland, Oct. 13, 1886. Latest record. New Haven, Dec. 28, 1909 (Merrill); Portland, Dec. 15, 1891.

Spring migration. Average, March 15 — April 25. Earliest record. New Haven, March 20, 1888; Portland, Feb. 17, 1891. Latest record. New Haven, April 25, 1889 (L. B. W.), April 25, 1909 (J. Lamb); Portland, May 30, 1885.

Winter records. Merriam records[1] that Grinnell told him that over two hundred remained about the mouth of the Housatonic River during the winter of 1876-7. In January, 1904, a New Haven daily paper reported that a flock was wintering along the shore of the Sound east of Stonington. W. W. Coe[2] saw one shot in the Middlefield reservoir, Jan. 4, 1883. Three were shot from a flock of six at Clinton, Dec. 28, 1909, by C. A. Merrell (one in coll. of L. B. B.).

**Branta canadensis hutchinsi** (Richardson). Hutchins' Goose.

Very rare.

Linsley records it from Stratford. G. B. Grinnell[1] says it is recognized by the gunners about Milford (1877). E. H. Austin informs us that this species used to occur in small numbers at Stratford, and that he remembers seeing three, May 23, in the sixties, in the possession of a gunner at Milford Point. He also reports one shot in South Kent a few years ago (about 1900).

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[1] Merriam, Birds of Conn., p. 122.

[2] *O. and O.*, viii, 3, p. 24.

**Branta bernicla glaucogastra** (Brehm). Brant.

A rare straggler on the Sound in the fall and winter.

Linsley recorded the Brant as "common" in Stratford in the winter. Merriam[1] gives the following records: spring, 1877, Stratford Light, two killed (Grinnell); April 14, 1876, mouth of East Haven River, three seen (Osborne); spring, 1876, Connecticut River above Hartford, one shot (Dr. Wood).

The following recent records appear: 1893-4-5, a large number wintered off Stamford (Porter); Dec. 21, 1895, Stony Creek, a male taken by E. M. Cooper (in coll. of L. B. B.); Feb. 21, 1903, Stratford, two males and one female shot by G. Greenway (in coll. of L. C. S. and L. B. B.).

### Subfamily CYGNINÆ. Swans.

**Olor columbianus** (Ord). Whistling Swan.

The only records for Connecticut are as follows: Linsley mentions four specimens, two of which were killed, at Stratford; Merriam[2] records that two Swans were seen in Branford Harbor during a severe gale about the middle of March, 1876 (Beers), and several were seen at the same time near Milford (Grinnell); a young bird was shot off Grass Island, Guilford Harbor, by Mr. Reuben Hill, Nov. 2 or 3, 1893, and mounted by Capt. Brooks[3] (now in the possession of Mr. Norton of Guilford); an adult taken in Fairfield is in the Linsley collection of the Bpt. Sci. Soc.

## Order HERODIONES. Herons, Storks, Ibises, etc.

### Suborder IBIDES. Spoonbills and Ibises.

### Family IBIDIDÆ. Ibises.

**Guara alba** (Linnæus). White Ibis.

The only record for New England is one reported by Merriam[4] as seen by G. B. Grinnell, who wrote: "Late in the afternoon of May 23 (1875), I observed near Milford, Conn., a specimen of *Ibis alba*. I recognized the bird as it flew over me, and following it to a small pond, where it went down, discovered it perched upon a tree over the water. I carefully examined it with a good glass, at a distance of about one hundred and fifty yards, and by this means was enabled to note every detail of form and color. It was in full plumage, the white being pure, and the naked skin about the head bright red. After watching it for a few moments I tried to approach it, but before I came within gunshot it flew, uttering a hoarse cackle as it went off."

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[1] Merriam, Birds of Conn., p. 121.

[2] Merriam, Birds of Conn., p. 120.

[3] Reported by L. B. B., *Auk*, xi, 1, p. 74.

[4] Merriam, Birds of Conn., p. 110.

**Plegadis autumnalis** (Linnæus). Glossy Ibis.

Linsley obtained five specimens at Stratford.[1]

The only other record is that of Dr. J. Barratt[2] of Middletown, who wrote in the Middletown *Sentinel and Witness* for May 21, 1850, that "One of these rare birds (*Ibis falcinella*) was shot in Middletown on the banks of the Connecticut, May 9th, time of high flood. It has been carefully preserved and is now in the cabinet of Dr. J. Barratt." He adds, "The *Ibis falcinella* is very rarely seen in the United States. This is the first that has come to our notice on the Connecticut, and has not been known in this country many years." Since this article appeared, the specimen has been presented to the Wesleyan University Museum, Middletown, and is in good condition.

On page 92 in the copy of Nuttall's Manual (Water Birds) owned by Dr. Barratt, is the following marginal note in his handwriting: "My specimen, 28 inches, May, 1850. J. Barratt." (J. H. S.).

## Suborder **HERODII**. Herons, Egrets, Bitterns, etc.

### Family ARDEIDÆ. Herons, Bitterns, etc.

### Subfamily BOTAURINÆ. Bitterns.

**Botaurus lentiginosus** (Montagu). Bittern.

A common fall and less common spring migrant; rare summer resident. Most common during September and October, and April.

Fall migration. Earliest record. New Haven, Aug. 27, 1895; Portland, Sept. 14, 1892. Latest record. New Haven, Nov. 2, 1903; Portland, Oct. 24, 1890.

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[1] Merriam, Birds of Conn., p. 110.

[2] This specimen is also recorded in Merriam, p. 110, and by J. H. S. in the *Auk*, iv, 3, pp. 253-4.

Spring migration. Earliest record. New Haven, April 20, 1887; Portland, April 8, 1887; Columbia, March 26, 1894 (W. E. T.). Latest record. New Haven, May 4, 1898; Portland, May 21, 1907.

Summer records. June 9, 1892, Portland (J. H. S.); June 24, 1893, June 21, 1894, Quinnipiac Marshes, North Haven (A. H. V. and L. B. B.); June 20, 1904, Salisbury (J. H. S. and L. B. B.); May 30, June 11, 15, 1891, June 30, 1905 (E. S. W.), July 3, 1895, Litchfield (L. B. W.); July 23, 1910, Portland (J. H. S.).

Winter record. Dec. 29, 1904, Stamford, a male in perfect condition taken (in coll. of Hoyt).

Nesting records. June, Portland, eggs taken (J. H. S.); June 27, 1907, Litchfield, four young in nest (E. S. W.).

**Ixobrychus exilis** (Gmelin). Least Bittern.

A rather rare summer resident of the marshes along the coast, occasional inland. Formerly common.

Earliest record. May 29, 1875, Portland.

Latest record. Sept. 22, 1902, New Haven.

Nest. Usually a mere hollow of rushes fastened to the flags of a grass-grown marsh.

Eggs. 4-5; middle of June.

Nesting dates. Earliest record. June 8, 1898, five eggs (Hill). Latest record. June 27, 1876, one egg (Nichols).

Merriam[1] notes this species as a pretty regular summer resident, having been particularly abundant throughout the state during the season of 1875. At that same time W. W. C. informed Merriam that they bred regularly in the vicinity of Portland. Of recent years the Least Bittern has become relatively scarce.

Recent records: May, about 1896, Winchester, pair seen (Williams);[2] May, 1904, New Haven (A. A. S.); June 23, 1904, Stratford, a breeding pair taken by E. Perry, Jr.; June 18, 1907, Portland (J. H. S.); June 19, 1909, Morris Cove, New Haven, nest with four eggs (A. A. S.); Sept. 13, 1909, Goodspeed's Landing, bird taken (C. R. H.); June 15, 1910, New Haven, deserted nest with one egg (H. K. J.); July 23, 1910, Portland (J. H. S.).

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[1] Merriam, Birds of Conn., p. 113.

[2] Job, The Sport of Bird Study, p. 293.

### Subfamily Ardeinæ. Herons and Egrets.

**Ardea herodias herodias** Linnæus. Great Blue Heron.

A tolerably common spring and fall migrant. Very rare summer resident.

Spring migration. Average, April 1-20. Earliest record. New Haven, March 22, 1902; Portland, April 3, 1896. Latest record. New Haven, April 29, 1884, and 1890, May 16, 1907 (A. A. S.); Portland, May 11, 1875.

Fall migation. Average, Aug. 20 — Oct. 20. Earliest record. New Haven, July 14, 1893; Portland, Aug. 2, 1880. Latest record. New Haven, Nov. 16, 1904; Portland, Nov. 25, 1892; coast, Nov. 26, 1875 (Merriam).[1]

Summer records. June 2, 1877, New Haven (W. P. Nichols);[1] May 15, 1897, May 21, 1898, New Haven (L. B. B.); June 7, 1897, May 13, 18, June 3, 1905, Litchfield (E. S. W.). E. S. W. says this species is often seen in the summer at Bantam Lake, Litchfield. Nest found in Winchester about 1900 by Williams (Job).[2]

**Herodias egretta** (Gmelin). Egret.

An irregular transient visitor in late summer.

Connecticut records. Prior to 1877, a specimen was shot near Middletown (in Museum of Wesleyan University);[3] Grinnell reported seeing it on the marshes near Milford in September;[3] Dr. Wood reported one near East Windsor Hill "several years ago" (i. e., before 1877);[3] a pair, seen at Lake Saltonstall, July, 1876, and later not less than seven (F. S. Smith);[3] Aug. 2, 1878, and Aug. 11, 1882, specimens shot by J. R. Chalker near Saybrook (latter in coll. of J. H. S.);[4] April 1, 1883, Stamford, adult in full nuptial plumage taken (Schaler); Aug. 14, 1883, Hartford (W. E. T.);[5] 1883, East Haven (L. T. Hotchkiss, in Peabody Museum); July 29, 1897, July 30, 1898, Aug. 8, 1898, Stamford, young taken (Schaler); Aug. 19, 1897, Clinton, one shot; Aug., 1897, Quinnipiac Marshes, North Haven, one seen (Robertson); Aug., 1899, flock of a hundred seen near East Haven marshes, a number roosting nightly at Branford (Nichols); July 28, 1899, Kent, one taken by Hall (in coll. of H. K. J.);[1] July 25, 1906, Canaan, one shot (in coll. of Pease);[1] Aug., 1911, near Greenwich, one seen (P. G. Howes);[2] Aug. 15-30, 1911, West Haven, two seen (J. Hitchcock).

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[1] Merriam, Birds of Conn., p. 110.

[2] Job, The Sport of Bird Study, p. 293.

[3] Merriam, Birds of Conn., p. 111.

[4] *O. and O.*, vii, 24, p. 189; viii, 1, p. 4.

[5] *Auk*, iv, 1, p. 78.

**Egretta candidissima candidissima** (Gmelin). Snowy Egret.

Merriam[3] characterizes this species as "a rare accidental visitor from the South." He further states that Linsley saw it at Stratford and that Dr. Crary has taken it at Hartford (prior to 1877). C. L. R. of Norwich writes in *O. and O.*:[4] "In early October I have seen eleven Snowy Herons at the point (Groton Long Point) at once, at another time nine, and smaller groups in other seasons." Mr. Jno. C. Comstock, in his journal kept at Lyme, records five specimens seen July 28, 1853, and thirteen Aug. 16, 1853 (J. H. S.).

**Florida cærulea** (Linnæus). Little Blue Heron.

A rare straggler from the South.

Merriam[3] gives the following records: Linsley took it at Stratford; April, 1877, one seen in Lake Whitney (doubtful record); May (1876?), Suffield, one shot (doubtful record).

Other records: July 28, 1875, Wethersfield, two seen, a young male killed by Mr. Ransom T. Hewitt (in coll. of W. W. C., and recorded in part by Merriam); Aug. 12, 1881, Saybrook, a specimen in immature plumage obtained from a flock of about six (J. N. C.);[5] summer, 1895, one taken near New Haven and mounted by a local taxidermist; Aug. 4, 1897, Niantic, one taken (P. J. McCook); July 21 — Aug. 5, 1899, Lyme, seven seen, two taken (A. W. Brockway);[6] Sept. 15, 1899, Stratford, one young in a flock of three taken (in coll. of L. C. S.); April 27, 1900, Portland, female in adult plumage shot by Hurlburt (in coll. of J. H. S.); Aug. 2, 1901, Guilford, young shot (in coll. of L. B.

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[1] H. K. Job, The Sport of Bird Study, p. 294.

[2] *Oölogist*, xxviii, 9, p. 152.

[3] Merriam, Birds of Conn., p. 111.

[4] *O. and O.*, xvi, 4, p. 59.

[5] *O. and O.*, vi, 7, p. 51.

*Auk*, xvi, 4, p. 152.

B.); July 22 — Aug. 18, and Sept. 7, 1904, Niantic, one to ten seen (McCook).[1]

**Butorides virescens virescens** (Linnæus). Green Heron.

A common summer resident throughout the state, arriving early in May, and the majority leaving early in September.

Earliest record. New Haven, April 27, 1886; Portland, April 24, 1902.

Latest record. New Haven, Oct. 2, 1902, Oct. 15, 1898 (E. S. W.); Portland, Oct. 1, 1894; Guilford, Oct. 22, 1909 (H. E. Watrous).

Nest. In a cedar, hemlock, or white birch, as a rule, and at a height of from 8 to 30 feet from the ground. Frequently in a small colony, but often alone.

Eggs. 4 or 5, usually 5; the last of May.

Nesting dates. Earliest record. May 11, 1906, five eggs (E. S. W.). Latest record. July 8, 1882, five young (L. B. B.).

**Nycticorax nycticorax nævius** (Boddaert). Black-crowned Night Heron.

A summer resident from May to October.

Earliest record. New Haven, April 3, 1888; Portland, April 28, 1905.

Latest record. New Haven, Nov. 17, 1900; Portland, Nov. 12, 1902.

Nest. Usually high in the top of a pine or hemlock and in colonies.

Eggs. 3-5; the latter part of May.

Nesting dates. Earliest record. May 4, 1902, five eggs (Beers). Latest record. June 20, 1886, two eggs (Eames).

Colonies. Rocky Hill, 1872, hundreds reported breeding in a heronry;[2] Lake Whitney, prior to 1881, a colony in Heron Swamp — again occupied by many pairs in 1904 and later (Bennett); near Norwalk, 1903, twenty to twenty-five pairs breeding in a heronry (Canfield and Watrous), numbers greatly increased in 1904 (Perry); Wood[3] reported a rookery where

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[1] *Auk*, xxii, 1, p. 77.

[2] Merriam, Birds of Conn., p. 112.

[3] Samuels, Birds of New England, p. 410.

"thousands" bred, fourteen miles from East Windsor, now practically abandoned (J. H. S.).

Unusual record. Feb. 9, 10, and 11, 1880, a specimen flushed in the open spaces of water on the Thames River, Norwich, by C. L. R.[1]

Albino. Summer of 1894, Stamford, young bird, creamy white with markings of pale russet and écru-drab (W. H. Hoyt, in coll. of L. B. B.).

## Order PALUDICOLÆ. Cranes, Rails, etc.

### Suborder RALLI. Rails, Gallinules, Coots, etc.

### Family RALLIDÆ. Rails, Gallinules, and Coots.

### Subfamily RALLINÆ. Rails.

**Rallus elegans** Audubon. King Rail.

Rare.

Linsley found it breeding at Stratford; Merriam[2] reports a specimen in the possession of J. N. C., taken at Saybrook, Jan. 14, 1876; Sept. 17, 1879, Portland, female killed (in coll. of J. H. S.); *c.* 1882-5, specimens shot at Glastonbury, Wethersfield, and East Haddam (reported by Sperry to L. B. B.); Sept. 23, 1892, Middletown (W. E. T.); Sept. 1, 1895, Little River Marshes, Middletown, male taken (in coll. of C. H. N.); Sept. 5, 1901, Quinnipiac Marshes, North Haven, young male taken (G. V. Smith, in coll. of L. B. B.); Sept. 26, 1905, same location, young female (Sperry, in coll. of L. B. B.); April 22, 24, 1910, Leete's Island, two females trapped (in coll. of L. C. S.); J. N. C. informed L. B. B. that he had taken one set of eggs many years ago.

**Rallus crepitans crepitans** Gmelin. Clapper Rail.

A rather rare summer resident of the salt-water marshes of the western part of the state; occasionally wintering.

Earliest record. East Haven, May 24, 1879 (Woolsey).

Latest record. Fairfield, Nov. 13, 1891 (Eames).

Winter record. Feb. 9, 1900, Stamford (Hoyt).

Nest. A nest of rushes in the marshes.

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[1] *O. and O.*, v, 10, p. 78.

[2] Merriam, Birds of Conn., p. 115.

Eggs. 8-14; in June.

Nesting dates. Earliest record. June 17, 1893, eight eggs (Schaler). Latest record. June 25, 1891, twelve eggs (Lucas).

Recent records. Stamford, 1874, fourteen eggs, Sept., 1893, four taken, Feb. 9, 1900, male taken (Hoyt), June 17, 1893, female and eight eggs (Schaler), Sept. 27, 1893, female taken (Porter); Fairfield, Nov. 13, 1891, female taken (Eames); Stratford, June 25, 1891, twelve eggs taken (W. H. Lucas),[1] Sept., 1893, one taken (in coll. of L. C. S.); Milford, Dec. 20, 1892 [?] (A. H. V.), May 26, 1900, male taken (Beers); West Haven, May 30, 1904, female taken (L. B. B.); New Haven, 1882, twelve eggs (E. H. Barbour), Sept. 11, 1886, female taken (C. H. Webb); East Haven, May 24, 1879, male taken (Woolsey); Guilford, Sept. 10, 1884, female taken (L. B. B.); Saybrook, one record (J. N. C.).

**Rallus virginianus** Linnæus. Virginia Rail.

A rather rare summer resident from May to October, and a tolerably common fall migrant.

Earliest record. New Haven, May 19, 1904, April 20, 1906 (E. S. W.); Portland, April 22, 1910.

Latest record. New Haven, Oct. 29, 1904; Portland, Oct. 20, 1890.

Nest. In rushes in fresh-water marsh.

Eggs. 7-10; early in June.

Nesting dates. Earliest record. May 18, 1910, eleven eggs (C. G. H.). Latest record. July 3, 1892, ten eggs (J. H. S.).

**Porzana carolina** (Linnæus). Sora.

An abundant fall migrant in September and October, frequenting the wild rice and cat-tail rushes in the tidal marshes, as well as the marshes along the inland waterways. Rare in the spring.

Fall migration. Average, Sept. 1 — Oct. 25. Earliest record. New Haven, Aug. 23, 1902; Portland, Aug. 17, 1897. Latest record. New Haven, Nov. 1, 1895; Portland, Nov. 5, 1894.

Spring records. May 28, 1898, New Haven, a female taken (Andrews, in coll. of L. B. B.); June 3, 1905, Litchfield (E. S.

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[1] Recorded in Averill's Birds of Bridgeport as *Gallinula galeata*.

W.); May 1-5, 1908, May 17, 1909, May 16, 1910, Portland (J. H. S.).

Summer record. Aug. 12, 1900, Westville (G. V. Smith).

Winter record. Dec. 29, 1881, Hartford, a male shot (H. T. G.).[1]

Breeding records. 1882, Norwich, three sets of nine eggs each (C. L. R.);[2] May 30, 1909, Talmage Hill (New Canaan), eleven eggs (P. G. Howes).[3] Nested at Portland in the early sixties, and eggs taken at that time have ever since been in the coll. of J. H. S. No recent record.

Albino. Quinnipiac Marshes, Sept. 30, 1901, young female taken, colored yellowish tawny olive with markings of broccoli-brown (C. R. Hooker, in coll. of L. B. B.).

**Coturnicops noveboracensis** (Gmelin). Yellow Rail.

A fall migrant in October to our marshes; probably not uncommon, but seldom taken owing to its secretive habits.

Merriam[4] records that they breed about Middletown (W. W. C.), and that several have been taken near Milford (Grinnell) and Stratford (Linsley).

Earliest record. Little River Marshes, Middletown, Sept. 8, 1894 (in coll. of J. H. S.).

Latest record. Milford, Nov. 10, 1876 (Grinnell).[4]

Spring record. March 24, 1888, Gaylordsville, a male taken by E. H. Austin (in coll. of Bpt. Sci. Soc.).

Fall records since 1894. Middletown, Sept. 8 (1894)—Oct. 25 (1894), five taken (Gould, Strong, Tryon, in coll. of J. H. S.); Quinnipiac Marshes, Sept. 15 (1908)—Oct. 15 (1894), twelve taken (Andrews, A. Ganung, P. Stetson, Whitney, H. W. F., L. C. S., L. B. B., in coll. of H. W. F., L. C. S., and L. B. B.).

Breeding record. The only breeding record is that of W. W. C.,[4] who informed Merriam that they bred about Middletown in 1874 and 1875. A questionable record—probably a misunderstanding (J. H. S.).

**Creciscus jamaicensis** (Gmelin). Black Rail.

A rare summer resident.

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[1] *O. and O.*, vii, 15, p. 119.

[2] *O. and O.*, vii, 22, p. 173.

[3] *Oölogist*, xxviii, 5, p. 90.

[4] Merriam, Birds of Conn., p. 118.

Connecticut records. July 10, 1876, Saybrook, female sitting on nest of ten eggs (four eggs in coll. of J. N. C.);[1] June 13, 1884, Saybrook, nine eggs taken (J. N. C.);[2] July 11, 1893, Aug. 12, 1904, Quinnipiac Marshes, North Haven, flushed (?), but not obtained (L. B. B.); Sept. 14, 1904, Essex, young bird (Whitney, in coll. of L. C. S.).

**Crex crex** (Linnæus). Corn Crake.

The only record of this species in Connecticut is that of J. N. C. of Saybrook, who obtained an adult male, Oct. 20, 1887, in a swampy thicket at the head of a marsh some two miles from Long Island Sound. It is recorded and described in *O. and O.*, xiii, 3, pp. 45-6.

### Subfamily GALLINULINÆ. Gallinules.

**Ionornis martinicus** (Linnæus). Purple Gallinule.

A very rare accidental visitor from the South.

Merriam[1] records a specimen taken near Middletown, about 1855, and now in the Wesleyan University Museum; Henry R. Smith of Stamford mounted a specimen taken there in 1877, while Hoyt reports another from Stamford in the spring of 1884; a female was collected at Bridgeport, June 26, 1903, by J. H. Canfield (in coll. of Beers).

**Gallinula galeata** (Lichtenstein). Florida Gallinule.

A rather rare fall visitant, occasionally taken by sportsmen while shooting Rail.

Although Grinnell[1] called it a rather common summer resident, the only summer record which we have is a specimen in the Peabody Museum, taken by E. L. Coe, in New Haven, in June, 1899.

Coast records. Sept. 28, 1889, Stratford, female taken (in Averill coll. of Bpt. Sci. Soc.); Sept. 20, 1903, Sept. 15, 1904, Essex (in coll. of L. C. S.); Sept. 30, 1902, New Haven (H. Whitney); Sept. 4, 1906, Essex (F. F. Brewster, in coll. of L. B. B.); Oct. 16, 1906, Stratford (L. C. S.); Sept. 15, 28, 1908, New Haven (P. Stetson); Sept. 25, 1911, Stratford, two taken (H. W. B.).

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[1] Merriam, Birds of Conn., p. 119.

[2] *Auk*, i, 4, pp. 393-4.

Inland records. Sept. 23, 1892, young female, Sept. 21, 1894, young female, Oct. 15, 1895, female, Sept. 3, 1903, male shot at Little River Marshes, Middletown (in coll. of J. H. S.); Sept., 1907, Canaan, one shot by Stevens, who also saw one that had been shot there in Sept., 1906 (H. K. J.);[1] Sept., 1895, one collected at Litchfield by H. Sanford (E. S. W.); Oct. 12, 1908, Goodspeed's Landing, one shot (Brackett, in coll. of L. B. B.).

### Subfamily FULICINÆ. Coots.

**Fulica americana** Gmelin. Coot.

A tolerably common fall migrant in September and October; much rarer than formerly. Seldom seen in spring.

Earliest record. New Haven, Sept. 21, 1896; Portland, Sept. 19, 1893.

Latest record. New Haven, Oct. 3, 1888; Portland, Nov. 14, 1892.

Spring records. May 1, 1887, April 22, May 15, 1888, Portland (J. H. S.); April 2-23, 1910, West Haven (H. K. J.).

Summer record. July 19, 1906, Portland (J. H. S.).

## Order **LIMICOLÆ**. Shore Birds.

### Family PHALAROPODIDÆ. Phalaropes.

**Phalaropus fulicarius** (Linnæus). Red Phalarope.

An accidental visitor during migrations.

The first record is that noted by Merriam[2] (1877): "W. W. Coe has a specimen in his cabinet killed at Portland in September." May 22, 1881, Portland, one obtained by C. H. N.; Sept. 27, 1886, Hartford, female shot by W. E. T.;[3] Oct. 21, 1890, Portland, female shot by J. L. Goff (in coll. of J. H. S.); May 24, 1894, East Haven, a male in nuptial dress taken by L. B. B.; Nov. 24, 1895, Portland, male taken, Oct. 2, 1903, female shot (in coll. of J. H. S.); Sept. 25, 1908, West Haven, a young female shot by P. B. H. (in coll. of L. B. B.).

**Lobipes lobatus** (Linnæus). Northern Phalarope.

An accidental visitor in the spring and fall.

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[1] Job, The Sport of Bird Study, p. 294.

[2] Merriam, Birds of Conn., p. 103.

[3] *Auk,* iv, 1, p. 78; corrected, *Auk,* xi, 1, p. 74.

Connecticut records. Aug. 4, 1886,[1] Sept. 12, 1889, Quinnipiac Marshes, North Haven, males, taken by E. L. Munson; Aug. 24, 1893, West Haven, taken by A. H. V. (in coll. of Porter); May 20, 1894, Bridgeport, male killed by flying against electric wires (in coll. of J. C. A. M.);[2] May 21, 1894, Quinnipiac Marshes, four seen, two females taken (L. B. B.); May 22, 1894, East Haven, two males and a female secured (H. W. F.).

**Steganopus tricolor** Vieillot. Wilson's Phalarope.

The only record of this species in Connecticut is the specimen recorded by Linsley as killed in Bridgeport. It is a female in breeding plumage, and is now in the collection of the Bpt. Sci. Soc.

### Family RECURVIROSTRIDÆ. Avocets and Stilts.

**Recurvirostra americana** Gmelin. Avocet.

Merriam[3] notes the only specimen recorded from this state: 1871, between Saybrook and East Lyme, a specimen caught in an old seine strung out on the beach to dry, and kept alive for some time (J. G. Ely).

### Family SCOLOPACIDÆ. Sandpipers, etc.

**Philohela minor** (Gmelin). Woodcock.

A summer resident, though more common during migrations; occasionally wintering. Breeds in less numbers than formerly. Most common during March, and from Sept. 15 to Nov. 25.

Earliest record. New Haven, March 3, 1883; Portland, Feb. 28, 1878.

Latest record. New Haven, Nov. 22, 1894, Nov. 26, 1906 (E. S. W.); Portland, Nov. 28, 1895.

Winter records. Dec. 18, 1882, Dec. 31, 1895, New Haven (L. B. B.); Feb., 1884, New London County (C. L. R.)[4]; Jan. 26, 1890, Bridgeport (W. H. Lucas);[5] Jan. 1, 1903, East Haven (H. W. F.); Dec. 9, 1906, Dec. 28, 1907, New Haven (A. A. S.).

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[1] *O. and O.*, xii, 9, p. 156.

[2] *Auk*, xii, 1, p. 77; wrongly recorded as *P. fulicarius* (L. B. B.).

[3] Merriam, Birds of Conn., p. 103.

[4] *O. and O.*, ix, 2, p. 57.

[5] *O. and O.*, xv, 2, p. 31.

Nest. Eggs are laid on a bed of dry leaves or on moss, with no pretense of a nest.

Eggs. 4.

Nesting dates. Earliest record. March 24, 1886, egg ready for nest taken from bird (L. B. B.); March 29, 1898, four eggs (Hill). Latest record. June 3, 1875, Norwich, four eggs (C. L. R.).[1]

The strange habit of grasping its young between its claws and carrying it through the air in its flight has been noted both by J. H. S., May 30, 1874, and by L. B. B., April 27, 1894.

Albino. New Haven, Nov. 7, 1894, abdomen white, and rest of plumage very pale, taken by J. B. Robertson.

**Gallinago delicata** (Ord). Wilson's Snipe.

A tolerably common spring and fall migrant in April, October and November, but rapidly decreasing in numbers. Very rare summer or winter resident.

Spring migration. Average, March 25 to May 10. Earliest record. New Haven, March 29, 1898, March 19, 1894 (H. W. F.); Portland, March 18, 1874. Latest record. New Haven, May 13, 1882; Portland, May 14, 1874, May 13, 1909.

Fall migration. Average, Sept. 1 to Oct. 25. Earliest record. New Haven, Sept. 18, 1895; Portland, Sept. 1, 1892, 1893. Latest record. New Haven, Dec. 1, 1882; Portland, Dec. 7, 1877.

Winter records. Feb. 4, 1872, Portland (W. W. C.);[2] Jan. 22, 1896, New Haven (L. B. B.).

Summer records. Aug. 5, 1886, North Haven (E. L. Munson); Aug. 12, 1889, East Hartford, one found under a telegraph wire (W. E. T.).

Breeding record. May 13, 1874, Portland, nest with three eggs found and fully identified, since parent bird was on nest (J. H. S. and W. W. C.)[2]. Several birds of this species were in the meadow at the time and also on the following day, but we saw only the one nest (J. H. S.).

**Macrorhamphus griseus griseus** (Gmelin). Dowitcher.

Very rare; now merely an accidental fall migrant in July and August.

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[1] *O. and O.*, ii, 1, p. 2; and xiv, 11, p. 176.

[2] Merriam, Birds of Conn., p. 105.

Connecticut records. Merriam[1] characterizes it as "not rare during the migrations." Linsley took it at Stratford. Aug. 21, 1874, Saybrook, two shot by W. W. C., one in collection of J. H. S.; Aug. 20, 1892, Grove Beach, Clinton, a young male, Aug. 15, 1894, a young male and two young females (H. W. F.); July, 1892, and 1894, Stamford (Schaler); Aug. 27, 1897, Guilford, a young female (L. B. B.); Capt. Jas. Holt of Lyme informed W. E. T. that he had seen eight (about 1893).

**Macrorhamphus griseus scolopaceus** (Say). Long-billed Dowitcher.

The only record for Connecticut is that of an adult taken on the Quinnipiac Marshes, North Haven, Aug. 5, 1886, by Dr. E. L. Munson (in coll. of L. C. S.).

**Micropalama himantopus** (Bonaparte). Stilt Sandpiper.

A rare straggler in May, August, and September.

Connecticut records. June, 1874, three, Aug. 30, 1886, Quinnipiac Marshes, North Haven (in coll. of Dr. E. L. R. Thompson), incorrectly reported in Merriam[2] and *O. and O.*[3] as Curlew Sandpipers (corrected by L. C. S.); Sept. 16, 1886, same locality, one young taken (E. L. Munson);[3] Sept. 17, 1886, near New Haven (in coll. of L. C. S.); Aug. 20, 1892, Grove Beach, Clinton, adult female taken (H. W. F.); May 30, 1894, West Haven, adult female taken (L. B. B.).

**Tringa canutus** Linnæus. Knot.

A rare straggler on the coast in the spring and fall. Formerly "common during migrations."[4]

Connecticut records. Merriam records that W. W. C. has "found it about the Connecticut River near Middletown in summer"[4] [probably a misunderstanding as to species (J. H. S.)]. Aug. 21, 1874, Saybrook (J. H. S.); Sept. 20, 1882, West Haven, one taken (A. H. Baldwin); Sept. 9, 1885, same place, one young taken (Munson, in coll. of L. C. S.); Sept. 25, 1903, same place, young male (A. Ganung, in coll. of L. B. B.); Jas. Holt of Lyme says they were found in September (1893?); L. C. S. informs us that seven were shot in West Haven by Hotchkiss several years ago.

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[1] Merriam, Birds of Conn., p. 105.

[2] Merriam, Birds of Conn., p. 106.

[3] *O. and O.*, xii, 9, p. 156.

[4] Merriam, Birds of Conn., p. 107.

**Arquatella maritima maritima** (Brünnich). Purple Sandpiper.

A rare late fall migrant, frequenting the rocky islands off the coast, and an occasional winter resident.

Capt. Brooks wrote Merriam[1] that "Purple Sandpipers come here [Faulkner's Island] in early fall and stay till spring."

Connecticut records. Nov., 1879, Stamford, two taken by Hezekiah Weed (Hoyt); April 22, 1881, Saybrook, female taken (in coll. of J. H. S.); *c.* 1882, Saybrook, one secured (J. N. C.);[2] Nov. 10, 1883, Guilford, one secured from a small flock (L. B. B.); Nov. 28, 1885, Stony Creek (G. E. V., in Peabody Museum); Nov. 15, 1888, Stamford, one taken (Hoyt); Nov., 1891, Stamford, two taken by Hecker (Hoyt); Jan. 1, 1893, New Haven, one shot (C. Webb, in coll. of Porter); March 31, 1893, May, 1897, Dec. 18, 1897, Branford (L. C. S.); Jan. 1, 1894, New Haven (A. H. V.); Nov. 20, 1895, Stony Creek, one shot (E. M. Cooper); winter, 1898-9, a few seen frequently on the small rocky islands at the eastern end of the Sound (G. E. V.).

**Pisobia maculata** (Vieillot). Pectoral Sandpiper.

A common fall migrant; unknown in the spring.

Earliest record. New Haven, July 30, 1890; Portland, Sept. 25, 1890.

Latest record. New Haven, Oct. 21, 1895; Portland, Oct. 31, 1891.

The adults pass in August, Aug. 17 (1882) to Aug. 27 (1882, 1897). The young follow in September, Sept. 6 (1894) to Oct. 21 (1895).

Summer record. July 26, 1890, Quinnipiac Marshes, North Haven, flock of ten seen (Trowbridge).

A hybrid between *P. maculata* and *P. fuscicollis* was taken on the Quinnipiac Marshes, Aug. 4, 1894, by L. B. B. It was with a few Spotted Sandpipers, and was remarkably tame. No Pectoral or White-rumped Sandpipers were seen that day. This bird was an adult male with rather undeveloped genitalia, its remarkably unworn plumage also indicating that it had not bred. In general coloring it resembles *P. fuscicollis* in breeding plumage, the rump more nearly approaching that of *P. maculata.* The upper tail coverts are white, the feathers, as a rule, broadly banded or striped with brown. The breast feathers are washed with brownish, as in *P. maculata,* and their dark centers are broader than in *P. fuscicollis.* In measurements this bird is exactly halfway between males of the two species, and practically identical with females of *P. maculata:* length, 8.25 in.; extent, 16.62; exposed culmen, 1.07; wing, 5.07; tail, 2.46; tarsus, 1.12; middle toe with nail, 1 in. The sternum also is about the size of that of the female *P. maculata,* and intermediate between males of the two species.

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[1] Merriam, Birds of Conn., p. 106.

[2] *O. and O.*, vii, 24, p. 189.

**Pisobia fuscicollis** (Vieillot). White-rumped Sandpiper.

A tolerably common fall migrant on the coast in September and October. Rare inland.

Earliest record. New Haven, Aug. 24, 1895.

Latest record. New Haven, Oct. 19, 1904; Lyme, Oct. 21, 1893 (W. E. T.); Branford, Oct. 23, 1905 (L. C. S.).

Adults pass during September, Aug. 24 (1895) to Sept. 30 (1886). The young follow in October, Sept. 30 (1894) to Oct. 19 (1904).

Inland records. Oct. 30, 1891, Oct. 24, 1895, East Hartford (W. E. T., latter specimen in coll. of J. H. S.).

Unusual records. Nov. 4, 1896, Quinnipiac Marshes, North Haven, a wounded bird taken (L. B. B.); May 19, 1904, same place, one seen (L. B. B.).

**Pisobia bairdi** (Coues). Baird's Sandpiper.

A rare and probably accidental fall migrant.

Connecticut records. Oct. 28, 1887, West Haven, a female shot, Oct. 19, 1889, a male shot (L. B. W.);[1] Nov. 3, 1888, Stratford, female taken (C. K. A., Jr.);[2] Sept. 29, 1894, Bridgeport, two taken by H. H. Taylor (Eames); fall, 1901, Saybrook, several taken (J. N. C.); Sept. 14, 1904, West Haven, young male taken by A. Ganung (in coll. of L. B. B.); Sept. 9, 1910, Bridgeport, female taken (H. W. B.).

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[1] *Auk,* vii, 1, p. 89.

[2] *Auk,* vi, 2, p. 189.

**Pisobia minutilla** (Vieillot). Least Sandpiper.

A common spring and fall migrant along the coast; not rare inland.

Spring migration. Earliest record. New Haven, May 8, 1900, May 6, 1905 (A. A. S.). Latest record. June 5, 1894.

Fall migration. Earliest record. New Haven, July 14, 1904. Latest record. Sept. 22, 1883.

The old birds pass south about the middle of July, and the young birds follow during August and the first half of September.

Inland records. May 19, 1883, Portland, one taken (in coll. of J. H. S.); Sept. 9, 1892, Middletown, four killed (in coll. of J. H. S.); May 23, 1893, East Hartford (W. E. T.); May 17, 1895, Portland, three shot by C. H. N. (two in coll. of J. H. S.).

**Pelidna alpina sakhalina** (Vieillot). Red-backed Sandpiper.

A rare spring and tolerably common late fall migrant along the coast.

Fall migration. Earliest record. New Haven, Sept. 25, 1903. Latest record. New Haven, Oct. 29, 1895.

Spring record. May 19, 1904, Quinnipiac Marshes, North Haven (L. B. B.).

Almost all specimens of this Sandpiper taken in Connecticut are young birds.

A young female in the collection of L. B. B., shot by A. Ganung in West Haven, Sept. 29, 1904, is almost as small as a European Dunlin (*Pelidna alpina alpina*): length, 8.44; culmen, 1.42; wing, 4.51; tarsus, 1.12. It was very lean, as if it had traveled far without resting, whereas our Red-backed Sandpipers are usually very fat in the fall. It is only a trifle larger than an adult female Dunlin from England; but, as the chief character separating these races is the length of the bill, and as the bills of most sandpipers do not reach their full size until late in the first fall, it seems safer to consider this bird merely an unusually small Red-backed Sandpiper.

**Ereunetes pusillus** (Linnæus). Semipalmated Sandpiper.

An abundant spring and fall migrant on the coast; not rare inland.

Spring migration. Earliest record. New Haven, May 11, 1897. Latest record. New Haven, June 1, 1894.

Fall migration. Earliest record. New Haven, July 30, 1896. Latest record. Oct. 23, 1894.

The adults go south in August, Aug. 2 (1894) to Aug. 27 (1895), and the young follow in August, September, and October, Aug. 9 (1882) to Oct. 23 (1894).

Inland records. Sept. 25, 1890, Middletown, one killed (J. H. S.); Oct. 7, 1891, Middletown, seen by W. E. T. and S. R.

A partially albinistic young female with the wings largely white, in the collection of L. B. B., was taken in West Haven, Oct. 2, 1903, by A. Ganung.

Breeding record. The only breeding record is that appearing in Merriam,[1] of the four eggs found by Nichols in Branford, July 20, 1877; but an examination of the only one of these four eggs now extant (in the Brewer collection in the Museum of Comparative Zoölogy, Cambridge), by Mr. Outram Bangs and L. B. B., has proven this to be an unusually small egg of *Actitis macularia*. It does not resemble eggs of either the Semipalmated or the Least Sandpiper in shape, color, or markings, while in all these respects it is typical of *Actitis macularia*. We have therefore no breeding record of *E. pusillus*.

**Ereunetes mauri** Cabanis. Western Sandpiper.

Probably occurs regularly in the fall, but in so small numbers as to escape notice.

Connecticut records. Sept. 4, 1889, Lyme, six seen and three shot by W. E. T. (in coll. of J. H. S.);[2] Aug. 17, 1892, Clinton, young female taken (H. W. F.); Aug. 27, 1895, Quinnipiac Marshes, North Haven, young female shot (L. B. B.).

**Calidris leucophæa** (Pallas). Sanderling.

Formerly an abundant spring and fall migrant; now rare, and occurring regularly only in the fall.

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[1] Merriam, Birds of Conn., p. 105.

[2] *Auk*, ix, 4, p. 389.

Fall migration. Earliest record. New Haven, Aug. 20, 1902. Latest record. Oct. 20, 1902.

Spring record. May 13, 1878, Saybrook, one male taken by H. W. F. (in coll. of Brewster).

Inland record. Sept. 12, 1894, one male taken at East Hartford by W. E. T. (in coll. of J. H. S.).

Linsley took it at Stratford. Merriam[1] says it "occurs during migrations, and is extremely abundant in fall."

**Limosa fedoa** (Linnæus). Marbled Godwit.

Connecticut records. Aug., 1842, Stratford, an adult female (?) (Linsley, in coll. of Bpt. Sci. Soc.); Aug. 26, 1909, West Haven, adult female shot by Wm. Ganung (in coll. of L. B. B.).

**Limosa hæmastica** (Linnæus). Hudsonian Godwit.

Connecticut records. Stratford (Linsley[2] and E. H. Austin).[3]

On page 178 in the copy of Nuttall's Ornithology (Water Birds) owned by the late Dr. J. Barratt, of Middletown, Conn., is the following marginal note, in his handwriting, relating to this species: "A pair shot by Jenkins Oct. 25, 1845 — these were bought by me and set up." (J. H. S.)

Oct. 30, 1852, Lyme, taken by Jno. C. Comstock (MS. Journal of Jno. C. Comstock, J. H. S.); Oct. 11, 1897, Little River Marshes, Middletown, one shot by L. E. King (in coll. of J. H. S.).

**Totanus melanoleucus** (Gmelin). Greater Yellow-legs.

A tolerably common spring and more common fall migrant, but becoming rarer at both seasons.

Spring migration. Earliest record. New Haven, April 21, 1897; Portland, May 3, 1893. Latest record. New Haven, June 4, 1900; Portland, June 5, 1882; Litchfield, June 9, 1905 (E. S. W.).

Fall migration. Earliest record. New Haven, Sept. 3, 1886; Portland, Sept. 24, 1881. Latest record. New Haven, Nov. 3, 1906; Portland, Oct. 27, 1894.

Unusual records. March 25, 1893, West Haven (L. C. S.); Nov. 22, 1895, West Haven, wounded bird (A. H. V.); July,

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[1] Merriam, Birds of Conn., p. 107.

[2] Am. Jour. of Sci. and Arts, [1] xliv, 2, p. 267.

[3] Averill, Birds of Bridgeport, p. 8.

1897, New Haven, ten taken (Trowbridge); Dec. 11, 1902, Portland (J. H. S.).

**Totanus flavipes** (Gmelin). Yellow-legs.

A common fall migrant on the coast; less common on the inland waterways.

Earliest record. New Haven, July 26, 1894.

Latest record. New Haven, Nov. 10, 1883.

The young pass south in August and September, July 30 (1896) to Oct. 13 (1903).

Spring records. May 7, 1877, near Meriden, on a fresh-water pond (Merriam);[1] May 20, 1897, New Haven, one seen (L. B. W.).

Summer record. July 21, 1900, North Haven, eighteen taken (H. W. F.).

**Helodromas solitarius solitarius** (Wilson). Solitary Sandpiper.

A tolerably common spring and fall migrant in May, August, and September.

Spring migration. Earliest record. New Haven, May 10, 1898, April 29, 1905 (A. A. S.); Portland, May 1, 1905; Litchfield, April 27, 1905 (E. S. W.). Latest record. New Haven, May 26, 1882; Portland, May 19, 1909; Litchfield, May 31, 1892 (E. S. W.).

Fall migration. Earliest record. New Haven, Aug. 7, 1903; Portland, Sept. 8, 1887. Latest record, New Haven, Oct. 6, 1897; Portland, Oct. 13, 1892.

Unusual records. June 10 (Grinnell).[1] East Hartford, July 19, 1887, one shot, July 14, 1888 (W. E. T.).

**Catoptrophorus semipalmatus semipalmatus** (Gmelin). Willet.

Connecticut records. Linsley found it breeding at Stratford. Merriam[1] records that Grinnell took it late in the summer at Milford, and that W. W. C. took a nest containing three eggs at Madison, June 5, 1873. An adult in the Linsley collection of the

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[1] Merriam, Birds of Conn., p. 108.

Bpt. Sci. Soc. and a young specimen in the Averill collection of the Bpt. Sci. Soc. were taken at Stratford, the latter on Aug. 9, 1888. Aug. 12, 1887, West Haven, one from a flock of three shot by W. G. Van Name.

**Catoptrophorus semipalmatus inornatus** (Brewster). Western Willet.

Connecticut records. Sept. 3, 1885, West Haven, one young taken (in coll. of L. C. S.); Oct., 1888, Fayerweather Island, found dead by Averill (subspecies doubtful); Aug. 15, 1897, Stony Creek, two taken from small flock by A. H. V. ( in coll. of A. E. V. and L. B. B.); Oct., 1904, West Haven, eighteen taken by A. Ganung [?]; Aug. 26, 1909, West Haven, one young (W. Ganung, in coll. of L. B. B.).

**Bartramia longicauda** (Bechstein). Upland Plover. Bartramian Sandpiper.

Formerly a common summer resident, breeding here; now a rare spring and fall migrant, more often heard than seen when migrating.

Spring records. May 2, 1874, Portland, three seen (J. H. S.); May 3, 1901, New Haven (L. B. B.); May 10, 1905, Litchfield (E. S. W.); May 30, 1907, Washington (L. B. B.).[1]

Fall records. Sept. 20, 1882, West Haven (Baldwin); Sept. 1, 1886, Guilford (L. B. B.); Aug. 30, 1886, Aug. 13, 1895, 1903, New Haven (L. B. B.); Sept. 6, 1901, Litchfield ( E. S. W.); Sept. 5, 1910, Bridgeport, male taken (H. W. B.).

Summer records. Aug. 1, 1885, Portland (J. H. S.); July 3, 1888, Litchfield (L. B. W.); July 27, 1905, Litchfield (E. S. W.).

Season unrecorded. 1873, Stamford, several seen in hands of a taxidermist (Hoyt); 1874-6, Greenwich Point, seen (Hoyt).

Breeding records. Merriam[2] was informed by W. W. C. (1877) that large numbers of them bred on Plum Island off New London; June 8, 1879, Winchester, a set of eggs taken by Williams (H. K. J.);[3] May, 1902, Torrington, a pair evidently breeding found by Hanson (H. K. J.);[3] summer, 1904, Litchfield, pair with young seen (reported by E. S. W.).

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[1] *Bird Lore*, ix, 5, p. 217.

[2] Merriam, Birds of Conn., p. 109.

[3] Job, The Sport of Bird Study, p. 295.

**Tryngites subruficollis** (Vieillot). Buff-breasted Sandpiper.

A rare straggler in the fall.

Merriam[1] (1877) records that J. G. Ely reports two killed near Saybrook "a few years ago," and Dr. Crary has one in his collection shot near Hartford "some years ago."

Sept. 6, 1889, Quinnipiac Marshes, North Haven, a young male taken (E. L. Munson, in coll. of Porter); Sept. 30, 1895, same place, a young male (C. C. Trowbridge).

**Actitis macularia** (Linnæus). Spotted Sandpiper.

A common summer resident from May to August, the adults almost all going south before the middle of July.

Earliest record. New Haven, April 22, 1889, 1903; Portland, April 18, 1899.

Latest record. New Haven, Sept. 27, 1882; Portland, Oct. 15, 1895.

Nest. Eggs laid in a field of grain, the grass of a meadow, or a clump of weeds, usually not far from the water.

Eggs. 4; laid early in June.

Nesting dates. Earliest record. May 24, 1897, four eggs (Hill). Latest record. June 19, 1893, four eggs (Watrous); July 2, 1904, two eggs, almost hatched, but deserted (L. B. B.).

**Numenius americanus** Bechstein. Long-billed Curlew.

The only records for this species in addition to Linsley's record of taking it at Stratford appear in Merriam:[1] Capt. Brooks, Faulkner's Island, reported that "occasionally one stops here in the fall;" summer, 1873, Milford, seen by Grinnell; Saybrook, sometimes occurs in the fall, but rare (J. N. C.); taken near Hartford (Dr. Crary).

A young bird of this species is in the Linsley collection of the Bpt. Sci. Soc.

**Numenius hudsonicus** Latham. Hudsonian Curlew.

A rare straggler in spring and fall.

Connecticut records. Linsley took it at Stratford, and Dr. Crary at Hartford.[1] Shot at Lyme, Sept. 27, 1853, by J. C. Comstock, and his MS. journal contains this entry: "Lyme, Aug. 16, 1858, large flocks of this species" (J. H. S.). Aug. 27, 1877, Saybrook, two specimens killed (one in coll. of W. W. C.); June 4, 1886, East Haven, one shot (Mitchell, in coll. of L. C. S.); July 26, 1890, Quinnipiac Marshes, North Haven, one seen (L. C. S. and Trowbridge); *c.* May 18, 1896, Milford (in coll. of L. B. B.); Sept. 19, 1900, New Haven, three shot (seen in market by L. C. S.); Sept. 20, 1904, West Haven, young female taken by A. Ganung (in coll. of L. B. B.); Sept. 13, 1909, Sept. 4, 1911, Fairfield (H. W. B.).

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[1] Merriam, Birds of Conn., p. 109.

**Numenius borealis** (J. R. Forster). Eskimo Curlew.

Formerly an accidental visitor in the fall migration.

Connecticut records. Linsley took it at Stratford, and J. N. C. has a fine specimen killed at Saybrook, Oct. 13, 1874;[1] Sept., 1886, West River Marshes, New Haven, one killed by flying against a wire, given to L. C. S.; Sept. 12, 1889, Quinnipiac Marshes, New Haven, a male taken by E. L. Munson (in coll. of Porter).

## Family CHARADRIIDÆ. Plovers.

**Squatarola squatarola** (Linnæus). Black-bellied Plover.

The young are sometimes tolerably common along the coast in the fall migration, but the adults are always rare.

Spring migration. Earliest record. New Haven, May 28, 1894. Latest record. New Haven, May 30, 1894.

Fall migration. Earliest record. New Haven, Sept. 13, 1904; Stamford, Sept. 2, 1892 (Porter). Latest record. New Haven, Oct. 21, 1903.

Linsley took it at Stratford. Merriam[2] recorded the taking of a specimen in the fall (no date) at the mouth of the Connecticut River by W. W. C., and several taken by Dr. F. W. Hall, Oct. 18, 1873. An adult female in the collection of Porter was taken at Stamford, Sept. 2, 1892.

**Charadrius dominicus dominicus** (Müller). Golden Plover.

A rare fall migrant; formerly "common during migrations."[2]

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[1] Merriam, Birds of Conn., p. 109.

[2] Merriam, Birds of Conn., p. 102.

Fall migration. Earliest record. Guilford, Aug. 27, 1883. Latest record. West Haven, Oct. 25, 1909 (A. Ganung).

Merriam[1] records that Capt. Brooks informed him that they were "plenty at Guilford in spring and early fall," and occasional in the fall, at Faulkner's Island; Linsley found it at Stratford, and W. W. C. recorded it from Portland.

Other records. "Plentiful at Lyme, Sept. 1, 1858, 104 being shot on that day by John Grumley" (MS. notes of J. C. Comstock, J. H. S.); Aug. 27, 30, 1883, Guilford, three adults seen and one secured (L. B. B.); Oct. 24, 1885, Hartford, a young male flushed from a stubble field (W. E. T.);[2] Sept. 3, 1886, Quinnipiac Marshes, North Haven [?], a young bird taken (A. H. V., in Peabody Museum); Sept. 12, 1889, same place, one taken (Munson); Oct. 17, 1893, Portland, one shot (in coll. of J. H. S.); Sept. 25 to Oct. 2, 1903, West Haven, about twenty taken (A. Ganung); Sept. 20-1, 1904, four young, Oct. 20, 1906, fifteen, Oct. 7, 1907, two, Sept. 15, Oct. 25, 1909, one, all at West Haven (A. Ganung, many of these in coll. of L. B. B.); Sept. 19, 1908, Sept. 10, 1909, Sept. 4, 1911, Stratford (H. W. B.).

**Oxyechus vociferus** (Linnæus). Killdeer.

A rather rare summer resident, apparently increasing during the last decade.

Earliest record. New Haven, March 6, 1902; Portland, Feb. 24, 1875 (W. W. C.).[1]

Latest record. New Haven, Oct. 27, 1911 (H. K. J.); Middletown, Nov. 6, 1908 (J. H. S.).

Connecticut records. Mr. J. C. Comstock, in his MS. notes, records seeing them at Lyme during the whole winter of 1851-2 (J. H. S.); April 5, 1875, Middletown, male killed (J. H. S.); March 12, 1886, Saybrook (J. N. C.); Aug. 4, 1886, Quinnipiac Marshes, North Haven, one taken (Munson); April 22, 1887, New Haven (L. B. W., one in coll. of L. C. S.); April 16, 1888, New Haven (Webb); summer, 1889, North Haven (Munson); Feb. 1, 1889, May 23, 1902, May 25, July 2, 1904, taken, Sept. 15, 1902, Aug. 13, 1903, heard, near New Haven (L. B. B.); Nov., 1892, New Haven (seen in gun store, Dec., by L.

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[1] Merriam, Birds of Conn., p. 102.

[2] *Auk*, iv, 1, p. 78.

B. B.); July 28, 1894, Bloomfield, adult and young (W. E. T., in coll. of L. B. B.); Aug. 18, 1894, East Haven, three shot, Aug. 21, one shot (recorded by H. W. F.); July 9, 1896, East Hartford, adult and young (W. E. T., in coll. of L. B. B.); May, 1901, Newtown (Hamlin); March 6, 1902, Stony Creek (in coll. of L. B. B.); July 17-18, 1905, Mt. Tom (H. Sanford); Oct. 8, 1906, one, Oct. 11, three, Oct. 13, one shot, West Haven (A. Ganung, in coll. of L. B. B.); Nov. 6, 1908, Middletown (in coll. of J. H. S.); March 18, 1911, Milford, male (H. W. B.); Oct. 27, 1911, West Haven (H. K. J.).

Breeding records. According to Merriam,[1] W. W. C. informed him (1877) that it bred on Plum Island and in the vicinity of Portland; Guilford, two eggs collected many years ago (E. C. M. Hall, in Peabody Museum); "about twenty years ago," a set of eggs taken in Winchester by Williams (H. K. J.);[2] May 14, 1898, Darien, four eggs taken (Howes);[3] July, 1901, Bridgewater, nest with four eggs found (recorded by G. L. Hamlin); 1906, Danbury, a pair watched nesting and rearing their young (G. L. Hamlin). Formerly nested in Bloomfield in considerable numbers.

An unusual flight of Killdeer took place along the New England coast the latter part of November, 1888. Only two specimens, however, were reported from Connecticut.[4]

**Ægialitis semipalmata** (Bonaparte). Semipalmated Plover.

A common spring and fall migrant along the coast in May, August, and September; rare inland.

Spring migration. Earliest record. New Haven, May 11, 1897; East Haven, May 1, 1880 (Woolsey). Latest record. New Haven, June 1, 1894.

Fall migration. Earliest record. New Haven, July 30, 1896. Latest record. New Haven, Oct. 31, 1902.

Inland records. June 4, 1875, Portland, female taken by C. H. N. (in coll. of J. H. S.); Sept. 17, 1891, East Hartford, one shot (W. E. T.); May 22, 1894, Portland, specimen shot by C. H. N.; June 3, 1905, Litchfield (E. S. W.).

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[1] Merriam, Birds of Conn., p. 102.

[2] Job, The Sport of Bird Study, p. 296.

[3] *Oölogist,* xxviii, 1911, p. 151.

[4] Chadbourne, *Auk,* vi. 3, pp. 255-263.

**Ægialitis meloda** (Ord). Piping Plover.

Formerly a summer resident of the sandy beaches; now nearly or quite extinct in the breeding season, and very rare in the migrations.

Connecticut records. Merriam[1] recorded that it had been found breeding at Stratford (Linsley) and Saybrook (J. N. C.), and W. W. C. has taken it at Portland; Samuels[2] (1872) stated that it was "pretty abundantly distributed along the coast of New England as a summer resident;" Aug. 29, 1886, West Haven, one taken by E. L. Munson; May 28, 1888, Bridgeport, an adult male collected by C. K. A. (in coll. of Bpt. Sci. Soc.); Sept., 1904, New Haven Harbor, one seen by L. C. S.

**Ochthodromus wilsonius** (Ord). Wilson's Plover.

Accidental visitant.

Taken at Stratford by Linsley.[1] Seen at Bridgeport, July 28, 1888.[3]

### Family APHRIZIDÆ. Surf-birds and Turnstones.

#### Subfamily ARENARIINÆ. Turnstones.

**Arenaria interpres morinella** (Linnæus). Ruddy Turnstone.

A rather rare migrant frequenting the rocky islands in the Sound. Occasional about inland waters.

Connecticut records. Aug. 14, 1883, Faulkner's Island, several (L. B. B.); Sept. 1, 1883, June 27, 1884, several (L. B. B.); Sept. 9, 1885, New Haven (in coll. of L. C. S.); May 24, 1886, Saugatuck (in coll. of E. S. W.); May 13, 1888, Portland, one killed by J. L. Goff; Aug. 20, 1904, West Haven (A. Ganung, in coll. of L. B. B.); Sept., 1904, West Haven (seen by L. C. S.); Sept. 1, 5, 1910, Stratford (H. W. B.).

**Hæmatopus palliatus** Temminck. Oyster-catcher.

The only record is that of Linsley,[4] who says (1843): "The Oyster-catcher is now rare here, but fifteen years since they were not very uncommon in autumn."

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[1] Merriam, Birds of Conn., p. 102.

[2] Samuels, Birds of New England, p. 421.

[3] Averill, Birds of Bridgeport, p. 9.

[4] *Am. Jour. Sci. and Arts,* [1] xliv, p. 265; quoted by Merriam, Birds of Conn., p. 103.

## Order **GALLINÆ.** Gallinaceous Birds.

### Suborder **PHASIANI.** Pheasants, Grouse, Partridges, Quails, etc.

### Family ODONTOPHORIDÆ. Bob-whites, Quails, etc.

**Colinus virginianus virginianus** (Linnæus). Bob-white.

A common resident, especially near the coast, but rather rare in the northwestern part of the state.

Nest. Eggs laid on a bed of leaves, on the ground in a field or meadow.

Eggs. 10-32; in June.

Nesting dates. Earliest record. June 4, 1902, twenty eggs (Beers and J. C. A. M.). Latest record. Aug. 7, 1892, fourteen eggs (Beers).

A nest containing thirty-two eggs of this species (possibly laid by two females) was seen in North Haven by H. W. F. in the spring of 1903, and on revisiting the nest a few days later he found that all had hatched.

This species suffered severely during the cold winters of 1903-4 and 1904-5, and was almost exterminated over a large part of the state. Since then, and for some years earlier, large numbers of Quail from the South and West have been released, so that now it is impossible to determine what proportion of Connecticut Quail are descendants of the original stock.

### Family TETRAONIDÆ. Grouse, Spruce Partridges, Ptarmigans, etc.

**Bonasa umbellus umbellus** (Linnæus). Ruffed Grouse.

A common resident.

Nest. Eggs laid on the ground under a log or fence or at the foot of a stump in the woods or brush land.

Eggs. 12-16; early in May.

Nesting dates. Earliest record. May 4, 1892, fifteen eggs (Beers). Latest record. May 26, 1885, thirteen eggs (L. B. B.).

An interesting albino taken by Mr. C. E. Alling, Litchfield, Oct., 1903, is entirely grayish or yellowish-white, the latter shade predominating on the head and upper parts. The dark markings of the plumage are plainly indicated in slate gray. Many of the tail feathers, although of full length, are still encased in their pin-feather sheaths, except at the tips.

**Bonasa umbellus togata** (Linnæus). Canada Ruffed Grouse.

Two Grouse taken by E. S. W. in Litchfield, about Nov. 28, 1906, and given in the flesh to L. B. B., belong to this subspecies, as do others collected there by E. S. W.

## Order **COLUMBÆ**. Pigeons and Doves.

### Family COLUMBIDÆ. Pigeons and Doves.

**Ectopistes migratorius** (Linnæus). Passenger Pigeon.

Formerly very abundant during migrations and occasionally breeding. Now virtually extinct.

The latest definite record we have of the presence of this bird in Connecticut is of one adult male and three young which Mr. Outram Bangs tells us he saw within thirty yards near Willimantic early in October, 1901.

Mr. Hoyt informs us the last record for Stamford was that of a female shot there in the fall of 1879; a young male taken by Andrew Bassett near Lake Saltonstall in October, 1882, is the last taken and preserved near New Haven (in coll. of L. B. B.); and a young male shot Oct 1, 1889, is the last record for Portland (in coll. of J. H. S.).

A flock of about two hundred doves, some of which were certainly Passenger Pigeons, was seen by L. B. B. in North Guilford on Sept. 4, 1883; a single bird was seen by him on Prospect Street, New Haven, May 13, 1882, and others in Guilford on Sept. 11, 1883. A pair of very large wild pigeons, believed to be of this species, was seen in East Haven by H. W. F. and L. B. B., May 20, 1893. In Portland J. H. S. recorded this species April 7, 16, May 13, and Sept. 26, 1887.

As to the abundance of the species at one time, Mr. Henry Townshend tells L. B. B. that his uncles have told him that in the old days it was an easy thing on a "pigeon morning" in September to shoot enough of these birds before breakfast to load a hay-wagon, with the sides on, full to the brim.

"Pigeon mornings" were the cool, frosty mornings of late

September and early October. To the top of the highest trees on the summit of the low hills east of New Haven long poles were fastened at an angle of about thirty degrees from a perpendicular, and near the bases of these trees huts of leafy branches were built in such a position that the hunter hiding within could rake the pole with a discharge of his gun. The migrating pigeons would alight on these poles, and great numbers were often killed in the early morning hours. Such pigeon-ambushes L. B. B. well remembers seeing often in the seventies. The pigeons were probably migrating along the coast, and L. B. B. has been told that after stopping for a few minutes on these hills they would fly to the salt-marshes of the Quinnipiac.

Regarding one of the last, if not the last, flight of any size recorded from Connecticut, Mr. Hill writes us. "On the afternoon of September 10, 1876, the writer and William Colfax went to Groton, across the river from New London, to shoot plover or shore birds that usually come along about this time during the fall migration. The wind had been blowing heavily from the northwest for some days. Nearing our destination, we observed flocks of birds circling and hovering over the woods near by. Investigation and a shot brought to hand birds we thought and proved to be wild pigeons. We bagged about three dozen, and when we turned homeward we could see flock after flock come along and alight in the woods for food and rest. None flew over the river, for it was near sunset. That evening I made arrangements with Hiram Chappell (still living) to try the pigeons again, and we were on the grounds by daylight next morning, the 11th, and soon the pigeons commenced to fly about, and I shot ninety-six and my friend as many more. It seemed to us that the whole town, as well as the inhabitants of Groton, were out gunning for pigeons. Old flint-locks, queen's arms, and boys with gun locks tied on with string — any kind of firearm that could kill a pigeon was called into service. The height of the flight was on this day. The large flocks were the most wary, flying high in air, and were made up of many small flocks that had evidently been detached and scattered in quest of food, and when on their way to catch up with the main flight their speed was marvelous. The Thames river, at its mouth, the point where the pigeons finally crossed as they flew to the westward, is about a mile wide, and many flocks would easily span this distance by one-half or three-quarters of a mile wide. The total number of pigeons in this flight was something wonderful and astounding. I shall never forget it. The flight lasted two days. You ask how many pigeons were in the flight? Seventy-five to one hundred thousand. And how many were killed? Remember the shooting was going on on both sides of the river; say sixty shooters averaged forty or fifty pigeons per man, 2500 per day. Two days, 5000. This is a conservative estimate. Everybody had pigeon pot-pie. As to ammunition, the boys always tell that on the two days the only available shot to be had was buck shot. Ammunition dealers were cleaned out. The crops of the pigeons were filled with acorns. Mr. Chappell and I have gone over the event carefully."

One morning early in the fall during the seventies, possibly at the same date recorded by Mr. Hill, L. B. B. visited Guilford and found the Green strewn with feathers of these birds that had been shot during a flight on the previous day.

On May 6, 1897, a dove was flushed by L. B. B. from the borders of a small swamp on the outskirts of New Haven, and to his surprise two eggs were seen lying on a few leaves on the ground in an open space about one foot wide, in a narrow line of alders, that stretched between a small clearing and the swamp. The eggs impressed him as unusually large, and the Mourning Dove is not known to nest on the ground in Connecticut. A few minutes later the bird was again flushed from the nest, and, after flying some distance, showing an unusually white tail, wide spread, as it flew, returned and settled in a tree about thirty yards away. There it was watched for some time through powerful opera-glasses; but the light was not very good and the position in which the bird sat not favorable for study. It was evidently either a Passenger Pigeon or a Mourning Dove, and appeared to be somewhat larger than the latter, and had distinct dark markings near the tips of the outer greater primary coverts. These markings seem to be usually present in females of *E. migratorius* and not in females of *Zenaidura macroura carolinensis.* The bird would not allow a nearer approach; and, as the Passenger Pigeon was practically extinct in Connecticut, and had never been known to breed on the ground, L. B. B. decided he was mistaken in thinking the size of the eggs abnormal, and collected them, as they were not far from a well traveled road. The eggs were well advanced in incubation and one of them slightly nest-cracked. They measure, respectively, 1.52 inches by 1.12, and 1.51 by 1.12. They are evidently either eggs of the Passenger Pigeon, or eggs of the Domestic Dove which had been substituted by some one for eggs of the Mourning Dove. Dr. Charles W. Richmond, who kindly compared these eggs with a series of eggs of the Passenger Pigeon in the U. S. National Museum, informed L. B. B. that they had more gloss than any eggs of the latter in the collection, but that, as most of these eggs had been taken from the oviducts of birds found in market, this difference was not conclusive. Although there is of course no possibility of certain identification the incident seems worth recording.

An egg in the cabinet of L. B. B. was collected by Mr. A. A. Kellogg of New Haven, in New Hartford before 1870. It measures 1.43 by 1.03 inches.

In the collection of J. H. S. are two eggs taken by W. W. C. in Portland. One was found May 29, 1873, the male pigeon being on the nest and afterwards shot and mounted; the other June 6, 1875. J. H. S. saw the latter nest, which was on a small tree and not over ten feet from the ground.

Mr. G. L. Hamlin writes that they formerly bred commonly near Neversink Pond. Near Bethel he knew of their last nesting in 1874, the nest being in a swamp maple near the edge of a small tract of woodland; but the young birds were taken from the nest by a Cooper's Hawk, and that was seen by his father. In September, 1880, he saw the last large flock, some 500 birds. In August and September, 1892, a flock of seven frequented a field of buckwheat near his home in Bethel for about a month, and one bird he shot was in full moult and therefore not preserved. A single bird was seen by him in 1893, and no more until September, 1902, when for some time a flock of twenty-seven frequented a field of buckwheat and new mown rye. Of this flock all he was able to secure were the feathers of wings and tail of one that had been killed by a hawk.

**Zenaidura macroura carolinensis** (Linnæus). Mourning Dove.

A tolerably common summer resident from April to October, decreasing in recent years. Occasionally winters.

Earliest record. New Haven, March 18, 1882; Portland, April 23, 1892.

Latest record. New Haven, Oct. 30, 1897; Portland, Nov. 30, 1895.

Winter records. Dec. 19, 1884, Jan. 20, 1896, Portland; Jan. and Feb., 1894, Lake Saltonstall, East Haven (A. J. G.); last week in Dec., 1901, North Haven (Ludington); Feb. 20, 1882, Melrose (Thompson);[1] Jan. 16, 1883, Saybrook (J. N. C.);[2] Feb. 16, 1911, Portland (J. H. S.).

Nest. Most frequently in an evergreen, but occasionally in a deciduous tree or in the fork of a kalmia, at the height of from three to fifteen feet from the ground.

Eggs. 2; in May.

Nesting dates. Earliest record. April 29, 1894, two eggs (L. B. B.). Latest record. July 27, 1889, Norwalk, two fresh eggs (W. I. C.).[3]

## Order **RAPTORES**. Birds of Prey.

### Suborder **SARCORHAMPHI**. American Vultures.

### Family CATHARTIDÆ. American Vultures.

**Cathartes aura septentrionalis** Wied. Turkey Vulture; Turkey Buzzard.

A rare visitor from the south.

Connecticut records. Linsley recorded it as "not uncommon" when he was a child, "having at that period counted twenty in a flock in Northford in the month of August;" while an old hunter told J. N. C. that they used to be very common about the mouth of the Connecticut;[4] Merriam further records that Dr. W. O. Ayers took one at New Haven in 1853, J. N. C. saw them at Saybrook prior to 1873, Dr. Wood saw one at East Windsor Hill in 1874, Rev. J. H. Hand took one at Cromwell,

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[1] *O. and O.*, vii, 23, p. 181.

[2] *O. and O.*, viii, 10, p. 80.

[3] *Oölogist*, vi, 12, p. 231.

[4] Merriam, Birds of Conn., pp. 91-2.

Sept. 23, 1874, at Westbrook, Oct. 16, 18, 1875, and Grinnell reported one taken by Merwin at the mouth of the Housatonic River in June, 1875.

Fall, 1879, Stamford, one seen (Hoyt); April 20, 1882, North Stonington, one shot by O. G. Brown (in Peabody Museum);[1] March 15, 1886, East Haven (L. C. S.); Aug., 1888, Stamford (Hoyt); April 23, 1893, Stratford, one seen (Eames); Aug. 31, 1898, Old Lyme, one seen (Brockway);[2] Aug. 17, 1902, New Milford, one male caught by W. C. Pomeroy (H. K. J., in coll. of L. B. B.);[3] Aug. 21, 1902, Torrington, one seen by Hanson (H. K. J.);[3] Aug. 27, 1902, Gaylordsville, one seen by E. H. A. and H. K. J.; summer, 1903, Danbury, one wounded and kept in captivity (J. C. A. M.); May 19, 1907, Danbury, one shot (J. C. A. M., in coll. of L. B. B.).

**Catharista urubu** (Vieillot). Black Vulture.

Besides the doubtful record referred to by Merriam[4] of three specimens killed by J. H. Hand at Westbrook, Aug. 10, Sept. 12, 21, 1874, the only records for Connecticut are: an adult male, shot by Robert Payne at East Lyme, July 6, 1901 (in coll. of Hill);[5] and a specimen seen at Bolton reservoir, Oct. 10, 1879, by Dr. Wm. Wood (MS. note to J. H. S.).

## Suborder **FALCONES**. Vultures, Falcons, Hawks, Buzzards, Eagles, Kites, Harriers, etc.

### Family BUTEONIDÆ. Hawks, Eagles, Kites, etc.

**Elanoides forficatus** (Linnæus). Swallow-tailed Kite.

Connecticut records. Summer, 1861, Portland, one seen, which "suddenly dove and arose with a snake in its talons," which it devoured in mid-air (H. W. C., recorded by Merriam);[6] July 2, 1877, Lyme, one seen (J. G. Ely, recorded by Merriam);[6] June 16, 1889, Saybrook, one seen, "an unmistakable specimen, gracefully soaring in slowly receding circles; his long, pointed, narrow wings, fully expanded tail with the outer feathers of great length, pure white under parts in contrast with the dark upper, presented distinctions so marked from all other native species that recognition was instantaneous and unmistakable" (J. N. C.).[1]

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[1] *O. and O.*, vii, 18, p. 141.

[2] *Auk*, xv, 1, p. 53.

[3] Job, The Sport of Bird Study, p. 296.

[4] Merriam, Birds of Conn., p. 93.

[5] *Auk*, xix, 1902, 1, p. 94.

[6] Merriam, Birds of Conn., pp. 76-7.

**Circus hudsonius** (Linnæus). Marsh Hawk.

A tolerably common summer resident from April to October. Occasional in winter.

Earliest record. New Haven, March 22, 1884, March 12, 1887 (L. B. W.); Portland, April 1, 1882.

Latest record. New Haven, Nov. 11, 1903; Portland, Nov. 3, 1908.

Winter records. Feb. 8, 1882, Dec. 18, 1903, New Haven (L. B. B.); Dec. 25, 1903, Bristol (F. Bruen).

Nest. Often built of sticks, lined with grass, and located on the ground or on a slight hillock in an open marsh of high grass.

Eggs. 3 to 7; the middle of May.

Nesting dates. Earliest record. May 9, 1878 (C. L. R.).[2] Latest record. June 18, 1884, three eggs (C. L. R.).[3]

**Accipiter velox** (Wilson). Sharp-shinned Hawk.

A tolerably common summer resident from May until October; abundant in the fall migration in September and early October. Occasional in winter.

Earliest record. New Haven, March 19, 1904, March 9, 1887 (E. S. W.); Portland, March 27, 1886, 1899.

Latest record. New Haven, Nov. 4, 1897; Portland, Nov. 23, 1909.

Winter records. Feb. 4, 1881, Jan. 19, 1887, Feb. 22, 1890, Feb. 4, Dec. 13, 1895, Dec. 3, 8, 1898, Portland (J. H. S.); Dec. 13, 1900, Woodbridge (Smith, in coll. of L. B. B.); Jan. 14, 1902, Northford (L. B. B.); Feb. 22, 1887, New Haven (L. B. W.).

Nest. Almost invariably in a hemlock or pine tree, occasionally in a maple, 10 to 50 feet above the ground. Nest made of hemlock or pine sticks and twigs, the larger ones on the outside, the smaller ones inside, with a small depression for the eggs.

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[1] *O. and O.*, xiv, 8, p. 123.

[2] *O. and O.*, ix, 2, p. 16.

[3] *O. and O.*, x, 2, p. 25.

Eggs. 3 to 7, usually 5; toward the end of May.

Nesting dates. Earliest record. May 7, 1896, two eggs (L. B. B.). Latest record. June 26, 1883, three eggs (C. L. R.).[1]

C. L. R. states that[2] "the first clutch almost always contains five, but, if the eggs are taken successively as laid, the normal clutch may run perhaps to fifteen or eighteen," e. g., May 23, 1880, seventeen eggs.[1]

Both ovaries were developed in 17 of 20 females, chiefly young, examined between 1902 and 1905 by L. B. B.

**Accipiter cooperi** (Bonaparte). Cooper's Hawk.

A tolerably common summer resident from April to October, though more common during the migrations; occasionally winters. This species is annually becoming rarer over most of the state.

Earliest record. New Haven, March 16, 1887, March 10, 1888 (Webb); Portland, March 14, 1898.

Latest record. New Haven, Nov. 19, 1904; Portland, Nov. 12, 1904.

Winter records. Feb. 20, 1888, Feb. 1, 1894, Dec. 30, 1902, New Haven (L. B. B.); Jan. 12, 1901, Portland (J. H. S.); Jan. 31, 1902, Saybrook (J. N. C.).

Nest. In a hemlock or deciduous tree, usually toward the center of a large piece of woodland; 30 to 70 feet above the ground.

Eggs. 4 to 6; usually 4 or 5; about the middle of May.

Nesting dates. Earliest record. April 28, 1884, one egg (L. B. B.); April 30, 1886, three eggs (Eames). Latest record. June 24, 1911, four eggs (C. G. H.).

A pair of hawks will breed year after year in the same woods, often in the same nest (C. L. R.).[3]

Frequently several days elapse between the laying of the different eggs of a set, oviposition usually occupying ten days.

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[1] *O. and O.*, xiii, 3, pp. 34-7.

[2] *O. and O.*, vii, 15, p. 117.

[3] *O. and O.*, ii, 4, p. 25.

For interesting articles on the nesting and breeding habits of Hawks in this state, consult those of C. L. Rawson, who has made a special study of Hawks in Norwich, as noted in the bibliography.

One instance of the development of both ovaries has been noticed by L. B. B.

**Astur atricapillus atricapillus** (Wilson). Goshawk.

A rather rare and irregular winter resident, occasionally appearing in considerable numbers.

Earliest record. Oct. 5, 1886, New Haven (L. C. S.).

Latest record. April 12, 1907, Guilford (S. E. Watrous, in coll. of L. C. S.).

Large flights recorded in January, 1897, especially in the northern and eastern parts of the state (J. H. S.); in early November, 1906, and on through to March, 1907, near New Haven (L. B. B.); and in the fall of 1907, in different parts of the state (J. H. S.).

There are about thirty-five records of this species being either seen or captured in this state.

Breeding record. H. K. J.[1] records that "Mr. Williams found a nest in Winchester, about fifteen years ago [about 1893]. It was in a chestnut tree, sixty feet up, and contained two eggs. He shot the female for identification, and has the eggs and complete data."

**Buteo borealis borealis** (Gmelin). Red-tailed Hawk.

A common resident of the wooded hills of the interior of the state; much rarer on the coast except in the fall migrations.

Most abundant (Portland) from April 15 to May 25, and from Oct. 1 to Nov. 25, although recorded there during the entire year. The majority pass through the state as migrants, but this species winters regularly in small numbers throughout the state, and is more common on the coast at that season than in summer.

Nest. Very large nest of sticks and twigs, usually in a deciduous tree, from 45 to 75 feet from the ground. It favors

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[1] Job, The Sport of Bird Study, p. 297.

"dry hillsides where the woods are rather open and a wide range of view can be had." (C. L. R.)[1]

Eggs. 1 to 3; early in April.

Nesting dates. Earliest record. March 24, 1903, two eggs (Beers). Latest record. April 30, 1888, two eggs (Eames); May 23, 1873 (W. W. C.).[2]

This species will occupy the same nest year after year unless disturbed, when it will build another nest in the vicinity (W. W. C.[2] and C. L. R.).[3]

Mr. Rawson also notes the facility with which they are mated when one of the pair is killed, the survivors often pairing within a week or two, leading to the supposition that the old ones probably pair with the young of previous years.[3]

**Buteo lineatus lineatus** (Gmelin). Red-shouldered Hawk.

A common resident of the lowlands of the larger river valleys and the marshy woodlands of the coast; the majority passing farther south in October and returning in March, but many wintering regularly throughout the state.

In breeding these hawks return regularly to the same woods, and often use the same nest as the previous year, unless that was robbed. In that case they usually take the one in which they had succeeded in raising their second set, or the nest occupied in an earlier year. If the first set is taken, a second set is laid in from three weeks to a month.

The following nesting records are a summary of 112 occupied nests of this species examined by L. B. B., as well as about 60 examined by C. L. R.[4]

Nest. Location: all in deciduous trees; chestnuts (72, L. B. B., 39, C. L. R.), oaks (22, L. B. B., 10, C. L. R.), maples (9, L. B. B., 1, C. L. R.), beeches (1 each), yellow birch, ash, and hickory. Height: average, 35-50 feet from the ground, with the extremes of 20 (C. L. R.) and 75 (L. B. B.). Situation in tree: usually in the forking of the trunk at the top of the tree, frequently lower down against the trunk at a point where two or more branches leave it, very rarely in the fork of a limb at some distance from the trunk (L. B. B.). Material: sticks, frequently lined with pieces of hemlock, cedar, pine, or ground pine (83, L. B. B.), or without evergreen (11, L. B. B.), or lined with leaves (C. L. R.). Oftentimes feathered. Old nests of crows and other hawks often utilized.

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[1] *O. and O.*, vi, 5, p. 37.

[2] Merriam, Birds of Conn., pp. 85-6.

[3] *O. and O.*, ii, 4, p. 25.

*O. and O.*, xvi, 1, pp. 1-19.

Eggs. 2-5, usually 3 or 4; about the middle of April. Set of 5 (L. B. B.), sets of 4 (17, L. B. B., 14, C. L. R.), sets of 3 (57, L. B. B., 27, C. L. R.), sets of 2 (25, L. B. B., 13, C. L. R.), sets of 1 (3, L. B. B.). Eggs from the same wood and probably from the same birds have usually a certain resemblance in size, color, or markings. The number of eggs in the first set seems to depend largely on the weather in March, a warm open March with little snow being followed by large sets, a cold and stormy March by small sets. The most heavily marked egg is usually laid first.

Nesting dates. Earliest record. March 30, 1894, two eggs (L. B. B.). Latest record. May 6, 1901, two eggs (L. B. B.). Late sets. May 28, 1899, four eggs (Hill, New London); June 1, 1884, two eggs (C. L. R., Norwich).

In actions at the nest these hawks vary greatly individually; some leaving silently almost as soon as one enters the woods and not returning, others waiting until the tree is struck before leaving the nest, when they perch near by, crying frequently, and swooping to within ten feet of the climber. As a rule, however, the degree of solicitude shown depends on the length of incubation of the eggs; the nearer the eggs are to hatching, the more anxiously the hawks protect them.

The egg of a Barred Owl in the nest of a Red-shouldered Hawk has twice been found by L. B. B.; both times in the same piece of woodland, which had been reduced from an extensive tract by wood-choppers, thus leaving few suitable nesting-places for large birds. One (April 13, 1901) contained three eggs of the Hawk and one of the Barred Owl, with the Owl on the nest; the other (April 1, 1902) contained two eggs of the Hawk and one of the Barred Owl, with the Red-shouldered Hawk on the nest. As the hawks' eggs were in both instances further advanced in incubation, this species was probably the original owner of both nests.

During the winter these hawks seldom circle high in the air, as is so common at other seasons of the year, although they have been noticed doing this (Feb. 14, 1903, L. B. B.).

Mr. C. L. Rawson of Norwich, who has made an extensive study of the hawks in that vicinity, has recorded in his numerous articles in *O. and O.* a considerable mass of interesting data on eggs of this species, peculiar markings, and the recurrence of these markings in one individual. Other data as to the number and description of eggs taken from the same bird in successive years are numerous, as well as descriptions of nests and their location. We refer those interested in the subject to his articles as recorded in the bibliography.

**Buteo platypterus** (Vieillot). Broad-winged Hawk.

A tolerably common summer resident from May to September, and common fall migrant in September; breeds most abundantly in Litchfield county.

Earliest record. New Haven, April 21, 1888; Portland, April 19, 1893.

Latest record. New Haven, Oct. 16, 1901, Nov. 13, 1906 (E. S. W.) [?]; Portland, Oct. 22, 1892.

Nest. Situated in the center of the deepest woodland accessible. They vary in material from nests like those of the Red-shouldered Hawk, well-lined with various soft materials, to others resembling those of Cooper's Hawk, a loose platform of sticks lined with a few square pieces of bark.

Eggs. 2 or 3; about the middle of May.

Nesting dates. Earliest record. April 19, 1884, one egg, later three (L. B. B.); May 6, 1900, two eggs (Blackwood); May 14, 1894, three young, ten days old (G. L. H.). Latest record. June 16, 1898, two eggs (H. W. F.).

The bird is very shy and is seldom seen on the nest.

One bird of this species with both ovaries developed has been found by L. B. B.

This species frequently predominates in the hawk flights described by C. C. T.[1]

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[1] Trowbridge, Hawk Flights in Connecticut, *Auk*, xii, 3, pp. 259-270.

**Archibuteo lagopus sancti-johannis** (Gmelin). Rough-legged Hawk.

A rather uncommon winter resident, living about the larger marshes from November to March.

Earliest record. New Haven, Nov. 4, 1897. Latest record. New Haven, March 8, 1901, April 20, 1889 (L. C. S.).

Connecticut records: Dr. Wood of East Windsor Hill occasionally found it abundant in that locality,[1] and took about forty specimens;[2] Merriam[1] saw it near New Haven, Nov. 20, 1875; Dec. 25, 1875, Feb. 16, 1880, specimens killed near East Windsor Hill (in coll. of J. H. S.); Sept., 1879, Stamford, one taken (recorded by Hoyt); Sept. (?), 1883, Saybrook (in coll. of J. N. C.);[3] Oct., 1884, near Stamford (Hoyt, in coll. of L. B. B.); March 30, 1887, Glastonbury (in coll. of J. H. S.); Feb. 17, 1888, New Haven (in Flint coll. of Brewster); April 20, 1889, New Haven (in coll. of L. C. S.); Nov. 16, 1892, Stamford (Schaler, in coll. of Porter); Dec. 8, 1894, New Haven (A. H. V., in coll. of L. B. B.); Jan. 31, 1895, Nov. 4, 1897, Jan. 16, 1899, Jan. 24, 1900, March 8, 1901, Feb. 7, Dec. 1, Dec. 18, 1903, between New Haven and Guilford (seen by L. B. B.); Dec. 24, 1896, Fair Haven, seen in taxidermist's shop (L. B. B.); Nov. 20, 1901, Cromwell, two (in coll. of J. H. S.); Feb. 24, March 6, 1906, New Haven (E. S. W.).

**Aquila chrysaëtos** (Linnæus). Golden Eagle.

A rare winter visitant.

Connecticut records. Winter, 1856-7, Hartford, adult taken, seen in the flesh by J. C. Comstock (J. H. S.); Dr. Wood occasionally saw it about Hartford (prior to 1877);[4] Nov. 13, 1875, Deep River, one shot (in coll. of H. W. F.); May, 1877, Saybrook, one seen (J. N. C.);[4] 1879, Southbury, female shot (Wood coll.); Oct. 29, 1881, Ragged Mountain, Barkhamsted, one young shot by H. Wedge of Riverton;[5] Nov., 1884, and Nov. 5, 1896, Stamford, two taken (recorded by Hoyt); Oct., 1887, Preston, one shot (in coll. of G. H. Martin);[6] Nov. 1, 1892,

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[1] Merriam, Birds of Conn., pp. 87-8.

[2] Samuels, Birds of New England, p. 576.

[3] *O. and O.*, viii, 10, p. 80.

[4] Merriam, Birds of Conn., p. 89.

[5] *O. and O.*, vi, 10, p. 76; 12, p. 94 (more fully described).

[6] *O. and O.*, xii, 12, p. 206.

Essex, adult female (in coll. of J. H. S.); Oct. 1, 1896, Woodbridge, one female shot (in coll. of A. E. V.);[1] Nov. 20, 1896, East Haven, young male trapped (in coll. of L. C. S.); Jan. 19, 1897, Salem, adult male trapped (in coll. of C. L. R.);[2] Oct. 9, 1909, East Haven (in coll. of L. C. S.).

**Haliæetus leucocephalus leucocephalus** (Linnæus). Bald Eagle.

A rather rare spring and fall migrant and occasional summer resident; formerly bred in more unsettled parts of the state, possibly a few still breeding.

Earliest record. New Haven, April 17, 1885; Portland, April 25, 1889; South Glastonbury, March 16, 1899 (seen by J. H. S.).

Latest record. New Haven, Sept. 10, 1883, Nov. 20, 1875 (Merriam).[3]

Winter records. Jan. 26, Feb. 25, 1891, Stamford (Hoyt); Dec. 25, 1893, Middletown (J. H. S.).

Summer records. Numbers of this species have been seen during May, June, July, and August, at various places in the state (Deep River, Haddam Neck, Litchfield, Middle Haddam, Middletown, New Haven, North Haven, Portland, Saybrook, Stratford, Stevenson) in 1880, 1882, 1883, 1886, 1888, 1890, 1891, 1905.

Breeding record. Job records[4] that "Late in April, about a dozen years ago (1896), Mr. Williams found in Winsted a nest on a rocky ledge which contained two good-sized young. Several years previously he had found another nest in an unclimbable tree, and also has seen young which could not have been raised far off."

**Haliæetus leucocephalus alascanus** C. H. Townsend. Northern Bald Eagle.

A young female was shot near Willimantic, Oct. 27, 1909, by G. H. Champlin, and sent to L. B. B. in the flesh by C. R. H. That the majority of Connecticut Bald Eagles belong to this subspecies, is the belief of L. B. B.

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[1] *Auk*, xiv, 1, p. 89.

[2] *Auk*, xiv, 2, p. 215.

[3] Merriam, Birds of Conn., p. 90.

[4] Job, The Sport of Bird Study, p. 297

## Family FALCONIDÆ. Falcons, Caracaras, etc.

### Subfamily Falconinæ. Falcons.

**Falco rusticolus obsoletus** Gmelin. Black Gyrfalcon.

There are only two records for this state: Winter, 1879, west of Stamford (¼ mile over the boundary in New York State, but probably driven there from Connecticut by the northeast gale then raging), killed by Dr. Chas. Rowell (seen by L. B. B.); Jan. 27, 1907, Durham, female shot by A. Banks (in coll. of J. H. S.).[1]

**Falco peregrinus anatum** Bonaparte. Duck Hawk.

A rare but probably regular fall migrant; a very rare summer resident.

Fall migration. Earliest record. New Haven, Sept. 29, 1903; Lyme, Sept. 14, 1895 (W. E. T.). Latest record. Guilford, Oct. 30, 1907 (L. C. S.).

Winter records. Feb. 23, 1876, Milford (Grinnell);[2] Jan. 19, 1894, Stamford (in coll. of Porter).

Spring records. April 30, 1886, Portland, male shot (in coll. of J. H. S.); May 9, 1888, Mt. Carmel (Webb and Searles); May 9, 1899, Mt. Carmel (Bernard); May, 1900, Hamden (Osborne); spring, 1910, Mt. Carmel (H. K. J. and Buttrick).

Nest. Eggs laid on a shelf of some precipitous cliff.

Eggs. 2-4; early in May.

Breeding records. May 25, 1861, Talcott Mt., near Hartford, four young (Moses, recorded in *Hartford Times,* June 29, 1861, and by Merriam);[2] summer, 1863, same locality, two pairs breeding (Dr. Wood);[3] May 1, 1872, Talcott Mt., three eggs taken by P. H. Woodford (J. H. S.); May 9, 1888, Mt. Carmel, three eggs (Webb and Searles, in coll. of L. B. B.); May 9, 1899, Mt. Carmel, two eggs (Bernard, in coll. of L. B. B.); spring, 1910, Mt. Carmel, one pair and empty nest (H. K. J. and Buttrick).

**Falco columbarius columbarius** Linnæus. Pigeon Hawk.

A tolerably common spring and fall migrant, most abundant in October. Occasional in winter.

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[1] *Auk,* xxvi, 4, pp. 429-430.

[2] Merriam, Birds of Conn., pp. 81-2.

[3] Samuels, Birds of New England, p. 11.

Spring migration. Earliest record. New Haven, March 30, 1904; Portland, April 24, 1873. Latest record. New Haven, April 25, 1885; Portland, May 25, 1882.

Fall migration. Earliest record. New Haven, Sept. 10, 1902; Portland, Sept. 9, 1899. Latest record. New Haven, Nov. 6, 1901; Portland, Nov. 6, 1876.

Winter records. Dec. 24, 1875, Portland; March 4, 1885, New Haven; Jan. 5, 1897, Portland; Dec. 6, 1900, and Jan. 17, 1905, New Haven; Dec. 25, 1903, Bristol (E. A. Smith).

**Falco sparverius sparverius** Linnæus. Sparrow Hawk.

A tolerably common resident, most frequently seen in the early spring and the late fall. More common in the northern half of the state.

J. H. S. and L. B. B. record this species during the entire year.

Nest. Hole in tree, oftentimes the deserted nest of a Flicker or other bird.

Eggs. 3 to 5; early in May.

Nesting dates. Earliest record. April 29, 1890, five eggs (Trowbridge). Latest record. May 20, 1882, five eggs (J. H. S.); July 4, 1900, four young (Hill).

This species was formerly rare, Merriam[1] thus characterizing it, adding that it breeds near Portland (W. W. C.) and sometimes near East Windsor Hill (Wood). Between 1890 and 1900, however, it became somewhat if not very common during migrations, and since then has been frequently noted. It is still comparatively rare as a breeder in this state.

### Family PANDIONIDÆ. Ospreys.

**Pandion haliaëtus carolinensis** (Gmelin). Osprey.

A tolerably common spring and fall migrant; a rare summer resident near the coast in the southeastern part of the state.

Spring migration. Earliest record. New Haven, March 24, 1904; Portland, March 25, 1903. Latest record. New Haven, May 30, 1901; Portland, May 20, 1882.

Fall migration. Earliest record. New Haven, Aug. 27, 1895;

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[1] Merriam, Birds of Conn., p. 84.

Portland, Aug. 11, 1897. Latest record. New Haven, Oct. 18, 1888; Portland, Oct. 18, 1893; Danbury, Nov. 13, 1892.[1]

Eggs. 2 to 4; early in May.

Nesting dates. Earliest record. April 22, 1897, three eggs (Hill). Latest record. July 4, 1870 (F. S. Smith).[2]

They do not breed in the vicinity of Portland (W. W. C. and J. H. S.), nor along the Connecticut River, except near its mouth, where J. H. H. reports a colony of twenty-two pairs at Niantic. C. L. R. reports them breeding commonly along the shores of the Sound in New London County, and in several swamps a dozen miles in the interior up the Thames River valley.[3] Mr. Williams has known a pair to nest in Litchfield County.[4] L. B. B. saw a specimen in Warren, Litchfield County, June 7, 1900, and E. S. W. saw one in Litchfield, July 1, 1893, and July 4, 1905. These last are our only inland records during breeding season.

## Suborder STRIGES. Owls.

### Family ALUCONIDÆ. Barn Owls.

**Aluco pratincola** (Bonaparte). Barn Owl.

A very rare accidental visitor from the south.

Connecticut records. Merriam[5] notes the following: Linsley took it at Stratford; about 1841, Hartford (Ayres); Oct. 28, 1868, Sachem's Head (in coll. of Wood); "some years ago" (before 1877), Madison (in coll. of Capt. Brooks).

Later records. About 1875, Stamford, one taken (Schaler); June 15, 1891, Leesville, one shot by W. Chase (in coll. of J. H. S.); Aug. 28, 1891, Litchfield, one shot (in coll. of L. B. W.);[6] 1892, Winsted, nest with six young in an old factory found by H. Kinney (H. K. J.);[7] 1893, same locality, same nest, set of seven eggs taken by Williams (H. K. J.); June 25, 1896, Portland, a young male taken (in coll. of J. H. S.); Sept. 11, 1903, Stratford, male (in coll. of L. C. S.); Sept. 14, 1906, Portland, one shot (in coll. of J. H. S.); Jan. 15, 1911, East Hartford, one taken (in coll. of J. H. S.). C. L. R. has recorded several specimens from New London County.

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[1] *O. and O.*, xvii, 11, p. 172.

[2] Merriam, Birds of Conn., p. 88.

[3] *O. and O.*, x, 6, p. 89.

[4] Job, The Sport of Bird Study, p. 297.

[5] Merriam, Birds of Conn., pp. 66-7.

[6] *Auk*, ix, 2, p. 202.

[7] Job, The Sport of Bird Study, p. 298.

### Family STRIGIDÆ. Horned Owls, etc.

**Asio wilsonianus** (Lesson). Long-eared Owl.

A common winter and rare summer resident.

Earliest record. New Haven, Oct. 25, 1904; Portland, Oct. 8, 1892.

Latest record. New Haven, March 21, 1904; Portland, March 25, 1875.

Nesting records. April (prior to 1877), Berlin, nest with four eggs (Brandegee);[1] April 25, 1880, Ellington, five eggs taken (J. M. Wade);[2] spring, 1881, Bristol, a set of eggs taken (E. N. Brandegee); May 9, 1886, Woodbridge, nest with four young (Augur); May, 1890, Northford, set of four eggs (Trowbridge, in Trinity College Museum).

Other summer records. July 1, 1885, Litchfield (L. B. W.); April 24, 1906, New Haven (L. B. W.); May 1, 1906, North Haven (L. B. B.).

**Asio flammeus** (Pontoppidan). Short-eared Owl.

A common fall and tolerably common spring migrant; most frequently noted in October and March; winters rarely.

Spring migration. Earliest record. New Haven, March 2, 1894, Feb. 17, 1905 (Sherman); Portland, Feb. 9, 1911. Latest record. New Haven, March 31, 1896; Portland, April 29, 1883.

Fall migration. Earliest record. New Haven, Sept. 7, 1906; Portland, Oct. 8, 1890. Latest record. New Haven, Nov. 29, 1884; Portland, Dec. 12, 1903.

A favorite haunt of these birds is the salt-water marshes, where they sometimes congregate in flocks. Between sixteen and twenty of these Owls were found by L. B. B. in the marshes at Guilford, Oct. 17, 1890, more than half of them being within a space twenty yards square.

Breeding records. "Nests on the ground. Not uncommon" (Merriam).[3] Dr. William Wood of East Windsor Hill recorded[4] that a nest was found "some thirty years ago" half a mile from his office, the nest being on elevated ground, in a meadow, and composed of fine grass, and containing four eggs; 1876, an egg presumably of this species found in the grass at Groton Long Point, and brought to C. L. R.[1]

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[1] Merriam, Birds of Conn., pp. 69, 70.

[2] *O. and O.*, vii, pp. 161-2.

[3] Merriam, Birds of Conn., p. 70.

[4] *O. and O.*, ix, 1, pp. 10-11.

**Strix varia varia** Barton. Barred Owl.

A common resident along the coast; rarer in the interior, where it is most common during October and November.

Nest. Usually in a hollow tree or in the deep crotch of a tree; frequently in old hawks' nests; most common location a chestnut tree; height from the ground, 6 to 45 feet; nest often heavily feathered, and so deep as to hide bird from observation.

Eggs. 2-4 (of 22 nests recorded by C. L. R.,[2] 7 contained 3 eggs and 15 contained 2 eggs each); March 25 — April 15.

Nesting dates. Earliest record. March 17, 1886, one egg (L. B. B.). Latest record. May 10, 1879, two eggs (C. L. R.).

J. N. C. wrote L. B. B. that he considered this species "the most destructive enemy of birds, game, and domestic fowls among all the Hawks and Owls."

In the winter the numbers of the resident birds are often augmented by a flight from the north. This was the case in the winter of 1882-3, when twenty-six were brought to Mr. Herrman, then taxidermist of the Peabody Museum; and again in the fall of 1894, when twenty-five were brought to A. H. V. to be mounted.

**Scotiaptex nebulosa nebulosa** (J. R. Forster). Great Gray Owl.

A very rare straggler from the north.

Connecticut records. Jan. 6, 1843, Stratford, one taken (Linsley);[3] Jan. 22, 1893, North Haven, a male secured by a farmer (A. H. V., in Peabody Museum); March, 1907, East Haven, one secured by an Italian and sold to a restaurant in New Haven, where it was purchased, a then freshly mounted specimen, by L. C. S.

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[1] *O. and O.*, xvi, 4, p. 59.

[2] *O. and O.*, x, 2, p. 25; xiii, 3, pp. 37-40.

[3] *Am. Jour. Sci. and Arts*, [1] xliv, 2, p. 253; recorded by Merriam, Birds of Conn., p. 70.

**Cryptoglaux funerea richardsoni** (Bonaparte). Richardson's Owl.

An extremely rare accidental visitor.

The only records for this state are: mid-winter, about 1860, near East Windsor, one captured and presented to Dr. Wood:[1] Nov. 12, 1906, Kent, a male found dead by an Indian woman (obtained by H. K. J., in coll. of L. B. B.).[2]

**Cryptoglaux acadica acadica** (Gmelin). Saw-whet Owl.

A rather rare resident, most frequently observed in the winter, but breeding rarely.

Of the 42 records which we have for this species, 39 were between October 12 and March 28, the other 3 being summer records. This Owl has been recorded from the vicinity of Portland (19 times, J. H. S.), New Haven (9), Stamford (3), Bridgeport (2), Milford (2), Chester, Stony Creek, Fairfield, Winsted (1 each), Litchfield (4), thus showing a pretty general distribution. Merriam[3] is of the opinon that the apparent scarceness of the bird may rather be due to its "diminutive size and nocturnal habits."

Summer records. April 1, 1894, Chester, a set of five eggs taken by H. Bennett (in coll. of H. W. F.); June 8, 1896, Bridgeport, one seen, and later its nest probably identified (Beers); May, 1895 (?), Winsted, a pair with three young seen in an old Crow's nest (Williams).[4]

These little owls seem to suffer both from the weather and from the persecution of larger owls. One in the coll. of Porter was found dead in very cold weather, and their remains have been found in the woods several times by L. B. B. One found April 10, 1893, had been apparently killed by an owl; and another was found in the stomach of a Barred Owl, which had been shot at Lake Saltonstall, March 3, 1883.

Development of both ovaries has been seen once by L. B. B.

**Otus asio asio** (Linnæus). Screech Owl.

A tolerably common resident.

Nest. In a hollow tree, most frequently an apple tree in an orchard.

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[1] Merriam, Birds of Conn., p. 73.

[2] Job, The Sport of Bird Study, p. 298.

[3] Merriam, Birds of Conn., p. 74.

[4] Job, The Sport of Bird Study, p. 299.

Eggs. 4 or 5; the last of April.

Nesting dates. Earliest record. April 9, 1910, three eggs (C. G. H.). Latest record. May 9, 1892, two eggs (Beers).

This species frequents even our largest cities, as one was seen by L. B. B. on New Haven Green on the evening of Feb. 22, 1885, and another on April 3, 1893.

**Bubo virginianus virginianus** (Gmelin). Great Horned Owl.

A tolerably common resident, especially of the wilder portions of the state.

Nest. This owl usually occupies the old nest of a hawk, crow, or squirrel, though occasionally building for itself. Height: 45-75 feet from the ground. Location: most frequently in a hemlock or pine, or perhaps a chestnut or cedar.

Eggs. 2-3; last of February or early in March.

Nesting dates. Earliest record. Feb. 19, 1877, two eggs (J. H. S.); March 9, 1904, three young (L. B. B.). Latest record. April 25, 1902, two eggs (Hill).

L. B. B. and H. K. J. have both noted an unusual habit of the parent birds in apparently destroying the nest when the young become old enough to balance themselves in the fork of the tree, thus removing the conspicuous nest and leaving the bird well protected by the harmony of its colors with the bark of the tree.

**Nyctea nyctea** (Linnæus). Snowy Owl.

At present a rather rare and irregular winter resident, probably absent most winters, but occasionally occurring in considerable numbers, especially along the coast. Most frequently recorded in November and December.

Earliest record. Stamford, Sept. 18 (Schaler), Oct., 1874 (Hoyt). Latest record. Branford, April 15, 1902 (G. V. Smith).

Recent records. Although this species was noted pretty regularly up to 1890 or thereabout, records in later years have been growing increasingly scarce. During the winter of 1901-2 large numbers of Snowy Owls appeared on the New England coast and not a few of them reached Connecticut; captures were reported during this period from Stonington, Mystic, Noank, New London, and Niantic by Hill, from Saybrook by J. N. C., from Clinton by J. Peck, from Milford by L. C. S., and from Branford by L. B. B. About April 15, 1902, Branford (G. V. Smith); Nov. 18, 1905, Nov. 20, 1906, Portland (J. H. S.); Nov. 19, 1905, Stamford (Porter); Nov., 1905, New Haven (L. C. S. and L. B. B.); Dec. 23, 1905, Danbury (J. C. A. M.); Nov. 22, 1910, New Haven (Minor).

**Surnia ulula caparoch** (Müller). Hawk Owl.

The following are the only records for this state: Nov., 1869, New Haven, bird secured by Dr. F. W. Hall (recorded by Merriam[1] as the first Connecticut specimen); winter, 1879, near Stamford, one seen at a distance of twenty feet in flight and plainly identified (Hoyt).

### Order **COCCYGES**. Cuckoos, etc.

### Suborder **CUCULI**. Cuckoos, etc.

### Family CUCULIDÆ. Cuckoos, Anis, etc.

### Subfamily Coccyzinæ. American Cuckoos.

**Coccyzus americanus americanus** (Linnæus). Yellow-billed Cuckoo.

A tolerably common summer resident from the middle of May to the middle of September.

Earliest record. New Haven, May 10, 1894, May 8, 1894 (A. H. V.); Portland, May 7, 1895.

Latest record. New Haven, Oct. 16, 1900; Portland, Oct. 17, 1894.

Nest. Usually in a bush or slender tree in a thicket; height from ground, 5 to 10 feet (one 40 feet); composed of sticks and twigs, and just large enough to hold the eggs.

Eggs. 3-5; usually early in June.

Nesting dates. Earliest record. May 24, 1898, four eggs (J. H. H.). Latest record. Aug. 26, 1889, two eggs (W. I. C.)[2]

Unusual records. June 7, 1894, a nest containing two eggs of this species and two of the Black-billed Cuckoo, with the female Yellow-billed sitting, was found by L. B. B.; about 1877, a single egg found in a Robin's nest along with eggs of the latter species (L. B. B.); two nests with five eggs each, found in summer of 1884 (C. E. L.).[1]

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[1] Merriam, Birds of Conn., p. 73.

[2] *Oölogist*, vi, 12, p. 231.

In a single apple tree, J. C. A. M. found, June 15, 1902, nests containing either eggs or young of the Yellow-billed Cuckoo, the Scarlet Tanager, Robin, Baltimore Oriole, Wood Thrush, and Least Flycatcher.

**Coccyzus erythrophthalmus** (Wilson). Black-billed Cuckoo.

A common but irregular summer resident from the middle of May to August; not nearly as plentiful now as in the nineties.

Earliest record. New Haven, May 10, 1904, May 7, 1905 (A. A. S.); Portland, April 23, 1886; Litchfield, May 9, 1905 (E. S. W.).

Latest record. New Haven, Sept. 14, 1903, Sept. 21, 1907 (A. A. S.); Sept. 28, 1875 (Merriam);[2] Portland, Sept. 19, 1899; Litchfield, Sept. 21, 1891 (L. B. W.); East Hartford, Oct. 3, 1887 (W. E. T.).

Nest. In a small bush or young tree in a thicket or occasionally in an orchard; 2 to 12 feet from the ground.

Eggs. 2-4, usually 3; early in June.

Nesting dates. Earliest record. May 18, 1891, one egg (J. C. A. M.). Latest record. Aug. 2, 1881, three eggs (L. B. B.).

Unusual records. May 29, 1896, nest containing three eggs of *C. erythrophthalmus* and one of *C. a. americanus*, and June 6, 1897, two eggs of the former with one of the latter (L. B. B.), in both instances the Black-billed Cuckoo being on the nest; June 7, 1893, nest containing seven eggs of the Black-billed Cuckoo (L. B. B.); June 10, 1894, three eggs, of which one measured only .75 by .61 inch (J. C. A. M.).

## Suborder **ALCYONES**. Kingfishers.

### Family ALCEDINIDÆ. Kingfishers.

**Ceryle alcyon** (Linnæus). Belted Kingfisher.

A common summer resident from April to October; rarely wintering.

Earliest record. New Haven, April 3, 1902, March 27, 1907 (A. A. S.); Portland, April 5, 1893.

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[1] *O. and O.*, ix, 10, p. 128.

[2] Merriam, Birds of Conn., p. 63.

Latest record. New Haven, Nov. 4, 1901, Nov. 13, 1875 (Merriam);[1] Portland, Nov. 22, 1895.

Winter records. Feb. 13, 1874, Hartford (Humphrey);[1] Jan. 14, 1883, Portland (W. W. C.);[2] Jan. 15, 1883, Middletown (C. H. N.);[3] Feb. 14, 1888, Seymour (Eames); Feb. 17, 1902, Saybrook (J. N. C.); Jan. 17, 1905, Stamford (Vanhavenberg, recorded by Hoyt); winter, 1905-6, a number wintering in Stamford (Porter); Jan. 20, 1906, North Haven (E. S. W.); New Haven, one seen, Dec. 25, 1905 — March 7, 1906, and Dec. 5, 1906 — March 17, 1907 (A. A. S.).

Nest. A burrow excavated in a sand-bank to the depth of 4½ to 7 feet; no nesting material as a rule for fresh eggs, while those incubated repose on a mass of small fish bones and scales.

Eggs. 4-10, usually 7; latter part of May.

Nesting dates. Earliest record. May 9, 1881, six eggs (Beers). Latest record. July 2, 1881, seven young (L. B. B.).

Unusual records. June, 1881, Litchfield, nest with ten young (L. B. W.).

May 10, 1904, a hole was found in a sand-bank near New Haven by L. B. B. about which a pair of Rough-winged Swallows were flying. Early in the morning of Monday, May 23, neither hole nor swallows were to be seen, all evidence of the former having disappeared by the caving of the bank, caused by the removal of sand. After some effort the entrance was found, a stick passing easily through the loose sand that concealed it. At a depth of about five feet a male Kingfisher was found sitting on seven eggs and a round pebble about the size of an egg. This bird must have remained there imprisoned since the carting of sand ceased on Saturday, although with one stroke of its powerful bill it could have regained its freedom, to burrow out being, apparently, beyond its mental power.

## Order **PICI**. Woodpeckers, Wrynecks, etc.

### Family PICIDÆ. Woodpeckers.

**Dryobates villosus villosus** (Linnæus). Hairy Woodpecker.

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[1] Merriam, Birds of Conn., p. 63.

[2] *O. and O.*, viii, 3, p. 24.

[3] *O. and O.*, viii, 4, p. 32.

A tolerably common resident; apparently more numerous in the winter.

Nest. In a cavity in a living limb, but usually a short distance below a dead limb of sufficient size to affect the density of the wood below. Location, an apple tree in an orchard or a deciduous tree in the woods. Height from ground, usually between 15 and 30 feet.

Eggs. 2-4; early in May.

Nesting dates. Earliest record. April 30, 1904, two eggs (L. B. B.). Latest record. May 30, 1901, four eggs (Hill).

**Dryobates pubescens medianus** (Swainson). Downy Woodpecker.

A common resident.

Nest. Usually in the dead limb of a tree in the orchard, woods, or along the roadside. (Of 13 nests recorded by J. H. S. six were located in willow trees or stumps, the remainder in poplars, maples, and black birch trees.) Height from ground, 10-40 feet. Building, April 30 — June 3.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 16, 1896, five eggs (H. W. F.); May 16, 1899, five eggs (Hill). Latest record, June 12, 1882, four eggs (J. H. S.).

Both the Downy and the Hairy Woodpecker excavate holes during the fall in which they pass the winter nights.

**Picoides arcticus** (Swainson). Arctic Three-toed Woodpecker.

Merriam[1] records that a specimen was taken at Simsbury in 1860 (in Shurtleff coll., Wesleyan University Museum), and that Dr. Wood had taken it at East Windsor Hill. These are the only Connecticut records.

**Sphyrapicus varius varius** (Linnæus). Yellow-bellied Sapsucker.

A tolerably common spring and fall migrant in April, October, and November; rarely wintering.

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[1] Merriam, Birds of Conn., p. 64.

Spring migration. Earliest record. New Haven, April 2, 1888; Portland, April 9, 1875. Latest record. New Haven, April 27, 1900; Portland, April 23, 1902.

Fall migration. Earliest record. New Haven, Sept. 28, 1898, Sept. 16, 1887 (H. W. F.); Portland, Sept. 17, 1894. Latest record. New Haven, Dec. 2, 1882; Portland, Oct. 25, 1896.

Winter records. Dec. 17, 1881, New Haven, young female taken (L. B. B.); Feb. 10, 1899, New Haven, one taken (Osborne and Austin).

Summer records. May 10, 1887, Portland (J. H. S.); May 6, 1893, Fairfield (Eames, in coll. of Beers).

Breeding record. H. K. J. reports[1] that Mr. Williams has in his possession two sets of eggs found in two nests in Winsted about 1893.

**Phlœotomus pileatus abieticola** (Bangs). Northern Pileated Woodpecker.

A rare winter and spring visitant; very rarely breeding.

Connecticut records. Linsley reported it from Stratford and New Haven;[2] W. W. C. noted one killed in Portland in November, 1876;[2] King took one at Suffield "several years ago" (prior to 1877);[2] spring, 1879, Stamford, two seen and plainly identified (Hoyt); Nov. 1, 1890, Granby, one taken by Welch (J. H. S.);[3] May 10, 1894, Neversink Swamp, Danbury, one seen (Hamlin); winter, 1894-5, Granby, one seen (Welch); Dec., 1900, Cornwall, one seen;[4] June 13, 1903, New Hartford, one shot by Sweetland (in coll. of J. H. S.).

Breeding records. May 30, 1901, Torrington, nest with one young found 20 feet from the ground in a pine tree in a very large cavity (Hanson);[5] Mr. Williams found nests of this species a dozen years ago (1896) in the vicinity of Litchfield.[5]

**Melanerpes erythrocephalus** (Linnæus). Red-headed Woodpecker.

A rare fall migrant; a very rare spring migrant and summer resident; an irregular winter resident; formerly an abundant resident.

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[1] H. K. Job, The Sport of Bird Study, p. 299.

[2] Merriam, Birds of Conn., p. 64.

[3] *Auk*, x, 4, p. 371.

[4] *Auk*, xviii, 2, p. 193.

[5] H. K. Job, The Sport of Bird Study, p. 300.

Old records. Dr. Wood of East Windsor Hill recorded[1] in 1881 that "forty years ago they were about as common as the Yellow-hammer [Flicker] in this part of the state. They entirely disappeared in 1847, and I did not see another specimen until 1860." Prof. Silliman informed Prof. A. E. Verrill in 1864 that these birds were abundant residents near New Haven as late as 1840. Linsley gave it from Stratford, and Merriam[2] recorded it as rare in 1877, noting also that it was rare in the vicinity of Portland (W. W. C. and J. H. S.). Hence this bird may be considered abundant until the forties, since which time it has become increasingly rare.

Fall records. Most of the recent records of this species in Connecticut are for the fall (late September and early October), when the Red-headed Woodpecker is occasionally noted accompanying the Flickers in their fall migration. New Haven, abundant between Oct., 1881, and March, 1882 (L. B. B.); also, 12 records by L. B. B., 3 by L. B. W., 2 by Webb, 1 by A. H. V. Portland, 9 fall records by J. H. S. Litchfield, 3 records by E. S. W., 1 by L. B. W. Stamford, 3 records by Hoyt. Bridgeport, 2 records by Beers and Eames.

Breeding records. Prior to 1863, East Windsor Hill, two eggs collected by Dr. Wood (in Peabody Museum); prior to 1880, Guilford, one egg taken (in coll. of L. B. B.); May 20, 1882, Portland, five eggs (J. H. S.); 1893, New Haven, nest with young (Hedges); May 10, 1898, New Haven, pair seen by A. H. V. and L. B. B.; June 23, 1906, Litchfield, set of four eggs (E. S. W.); brood of young seen about July, 1909, New Haven (A. A. S.).

Other spring records. Portland, May 15, 1883 (J. H. S.); New Haven, May 19, 24, 25, 1883 (L. B. B.); May 22, 1886, March 7, 1887, May 10, 1888 (Webb); May 20, 1902, May 19, 1907 (A. A. S.); spring of 1908, birds seen and nest found (N. H. Bird Club).

Summer records. July 3, 1876, June 3, 1898, Portland (J. H. S.); summer of 1882 rather common, June 29, 1884, New Haven (L. B. B.).

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[1] *O. and O.*, vi, 10, pp. 78-9.

[2] Merriam, Birds of Conn., p. 65.

Winter records. Dec. 31, 1872, Dec. 3, 1881, Dec. 30, 1895, Dec. 21, 1910, Portland (J. H. S.); Dec. 13, 1883, New Haven (L. B. B.).

**Centurus carolinus** (Linnæus). Red-bellied Woodpecker.

The following are the only Connecticut records: Linsley saw one "ascending an apple tree on the 16th of October, 1842;"[1] Dr. Crary informed Merriam[2] that he had killed it near Hartford, and E. I. Shores that he had taken a female, July 30, 1874, at Suffield. In the Linsley collection of the Bpt. Sci. Soc. is a mounted bird of this species collected by Sidney Mather, but it may not have been taken in Connecticut.

**Colaptes auratus luteus** Bangs. Northern Flicker.[3]

A common summer resident from April to October, the majority passing through the state as migrants; a few winter regularly.

Earliest record. New Haven, March 18, 1882;[4] Portland, March 10, 1898.

Latest record. New Haven, Nov. 10, 1903;[4] Portland, Nov. 3, 1908.

Winter records. New Haven, Dec., 1882, 83, 96; Jan., 1882, 83, 86, 94, 95, 98, 1901, 02, 03, Feb., 1883, 1904, 1912 (L. B. B.); Jan., 1884 (L. C. S.); Portland, Dec., 1885, 1908, Jan., 1898, 1909, 11, 12, Feb., 1910 (J. H. S.).

Fall flight. Large numbers of these birds fly westward along the coast late in September in the fall migration, flying early in the morning and alighting on the dead tops of trees. The mornings on which these birds are most abundant are similar in temperature conditions to those formerly known as "pigeon mornings"— clear, cool mornings following a sudden drop in temperature; and, until the law protecting these birds put a stop to the practice, "Yellow-hammer shooting" filled the gap left by the extermination of the Passenger Pigeon. Poles were fastened on the tops of tall and isolated trees, and the hunter waited below, hidden under a screen of boughs, and shot the Flickers as they alighted on this pole. Recently large numbers of these birds, sometimes as many as several hundred in the course of an hour in the early morning, flying rapidly westward, have been seen by L. B. B. near New Haven, Sept. 28, 1898, Sept. 25, 1900, Sept. 29, 30, 1903, Sept. 22, 1904.

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[1] *Am. Jour. Sci. and Arts,* [1] xliv, p. 263; recorded also by Merriam.

[2] Merriam, Birds of Conn., p. 65.

[3] Known also as the Yellow-hammer, Golden-winged Woodpecker, Highhole, and Pigeon Woodpecker. Called "Woodquoi" in Portland.

[4] Migrants.

Nest. A hollow excavated by the bird, or a natural cavity in a tree, at from 5 to 30 feet from the ground.

Eggs. 5-10, commonly 7 or 8; latter part of May.

Nesting dates. Earliest record. May 9, 1896, five eggs (J. H. S.). Latest record. June 19, 1872, seven eggs (J. H. S.); July 12, 1881, six young (L. B. B.).

L. B. B. found a nest, June 6, 1882, containing 11 eggs and 2 young; but, as one-half the eggs were perfectly fresh, the cavity was doubtless occupied by two females; one taken by C. W. W., May 21, 1888, contained 10 eggs.

Forty-eight holes made by woodpeckers were counted on one side of a large dead stump in the woods at Guilford by L. B. B., March 14, 1885, about twenty of them having been made by this species.

A. H. V. shot a Flicker with the upper mandible so deformed as to be useless for working on wood, Sept. 28, 1897; and L. B. B., one with the feet and head so badly infected with some kind of fungous disease that one eye was entirely closed, Oct. 16, 1906; both are in coll. of L. B. B.

## Order **MACROCHIRES**. Goatsuckers, Swifts, etc.

### Suborder **CAPRIMULGI**. Goatsuckers, etc.

### Family CAPRIMULGIDÆ. Goatsuckers, etc.

**Antrostomus carolinensis** (Gmelin). Chuck-will's-widow.

A mounted specimen in the Peabody Museum was caught alive by Mr. Decatur Morgan in New Haven, May 17, 1889.

This bird has been recorded also by Mr. A. H. Verrill.[1]

**Antrostomus vociferus vociferus** (Wilson). Whip-poor-will.

A common summer resident of woodland from May to August.

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[1] *O. and O.*, xiv, 6, p. 96.

Earliest record. New Haven, April 22, 1893; Portland, April 23, 1886.

Latest record. New Haven, Sept. 17, 1900; Portland, Sept. 21, 1893.

Nest. Eggs deposited on a few dead leaves on the ground, usually not far from the border of the woods.

Eggs. 2; the last of May.

Nesting dates. Earliest record. May 18, 1893, two eggs (J. H. S.). Latest record. July 4, 1884, two eggs (H. W. F.).

Late fall records. Nov. 1, 1880, Noank (C. L. R.);[1] Oct. 5, 1901, Westville (G. V. Smith, in coll. of L. B. B.).

**Chordeiles virginianus virginianus** (Gmelin). Nighthawk.

Formerly an abundant summer resident of the open pastures from the middle of May to September; now rare through most of the state in the breeding season, and occurring commonly only in the fall migration.

Earliest record. New Haven, May 7, 1888; Portland, April 28, 1888.

Latest record. New Haven, Oct. 17, 1890; Portland, Oct. 10, 1902.

Nest. Eggs laid on a rock, or on a bare place on the ground in a pasture; rarely on the flat roofs of houses in the cities.

Eggs. 2, rarely 1; early in June.

Nesting dates. Earliest record. May 26, 1896, two eggs (H. W. B.); May 26, 1900, two eggs (H. W. F.). Latest record. July 1, 1898, two eggs (J. H. H.).

Recent breeding records. Although this bird is reported as still tolerably common in the vicinity of Stamford both by Hoyt and Porter, throughout most of the state it is only a rare summer resident. The last pair seen near New Haven by L. B. B. was on May 15, 1900, this pair having left the open fields where they have been so persecuted, and taken refuge in a small opening in the woodland. The last nest recorded by J. H. S. from the vicinity of Portland is one found June 6, 1894.

A remarkable migration of these birds was witnessed by L. B. B. near Sachem's Head, Guilford, early in September, 1880 (?), late in the afternoon. Large numbers of these birds, collected in a broad band that extended from horizon to horizon, were watched flying westerly not far from the coast for about a quarter of an hour; the number of birds still passing showing little diminution when he was obliged to leave.

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[1] *O. and O.*, v, 10, p. 78.

### Suborder **CYPSELI**. Swifts.

### Family MICROPODIDÆ. Swifts.

### Subfamily CHÆTURINÆ. Spine-tailed Swifts.

**Chætura pelagica** (Linnæus). Chimney Swift.

An abundant summer resident from May until September.

Earliest record. New Haven, April 19, 1884, April 14, 1876 (Osborne);[1] Portland, April 18, 1896.

Latest record. New Haven, Oct. 29, 1888; Portland, Oct. 11, 1877.

Unusual record. New Haven, Nov. 7, 1907, one found dead after a heavy storm (L. B. B.).

Nest. In a chimney.

Eggs. 3 to 5; latter part of June.

Nesting dates. Earliest record. June 4, 1897, five eggs (J. H. H.). Latest record. July 4, 1890, three eggs (H. W. B.).

In the latter part of the summer these birds often collect in large flocks, sometimes three or four hundred strong, and spend the night together in some commodious chimney. Flying over this chimney in a broad circle toward dark, some of them are constantly dropping into it until all have disappeared for the night. One such roosting chimney was found in Portland by J. H. S. in 1877, and another in Guilford by L. B. B. in 1884.

### Suborder **TROCHILI**. Hummingbirds.

### Family TROCHILIDÆ. Hummingbirds.

**Archilochus colubris** (Linnæus). Ruby-throated Hummingbird.

A tolerably common summer resident from the middle of May until August, but apparently not as common as formerly.

Earliest record. New Haven, May 4, 1882; Portland, May 5, 1905.

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[1] Merriam, Birds of Conn., p. 59.

Latest record. New Haven, Sept. 29, 1882, Oct. 16, 1874 (Merriam);[1] Portland, Oct. 2, 1905.

Unusual record. March 1, 1902, Saybrook, a female beat itself against the panes in a window in the house of J. N. C., trying to reach some flowers inside.

Nest. Usually made of lichens or material closely resembling the bark of the tree on which it is located; as a rule from 9 to 12 feet from the ground, in orchard or garden, in the woods or in the shade trees of the city streets.

Eggs. 2 (invariably); early in June.

Nesting dates. Earliest record. May 13, 1891, two eggs (H. W. B.). Latest record. Aug. 4, 1881, two eggs (Smith);[2] Aug. 14, 1910, two eggs (C. G. H.).

## Order **PASSERES**. Perching Birds.

### Suborder **CLAMATORES**. Songless Perching Birds.

### Family TYRANNIDÆ. Tyrant Flycatchers.

**Muscivora forficata** (Gmelin). Scissor-tailed Flycatcher.

The only record of this species is a specimen shot, April 27, 1876, at Wauregan, by Mr. Carpenter. "The bird first attracted Mr. Carpenter's attention by its opening and closing the tail while flying about a small sheet of water in quest of insects."[3]

**Tyrannus tyrannus** (Linnæus). Kingbird.

A common summer resident, arriving during the first two weeks in May, and going south in August.

Earliest record. New Haven, May 1, 1896, April 13, 1877 (Dayan);[4] Portland, April 28, 1881. Thirty-five out of thirty-nine years' records for Portland were between May 1 and May 14 (J. H. S.).

Latest record. New Haven, Sept. 15, 1902; Portland, Sept. 10, 1887.

Nest. Usually on the topmost branch of an apple tree at from 12 to 25 feet from the ground.

Eggs. 2-6, usually 2 or 3; early in June.

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[1] Merriam, Birds of Conn., p. 62.

[2] *O. and O.*, vi, 7, p. 53.

[3] *Bull. Nuttall Ornith. Club*, ii, 1, p. 21; recorded also by Merriam, Birds of Conn., p. 50.

[4] Merriam, Birds of Conn., p. 49.

Nesting dates. Earliest record. May 29, 1898, four eggs (J. H. H.). Latest record. July 4, 1882, four eggs (L. B. B.).

Unusual sets. June 3, 1894, Branford, nest with six eggs found (Nichols); July 6, 1882, New Haven, nest with six young (L. B. B.).

Albinos. Aug., 1880, Laurel Hill, near Norwich, an albino Kingbird found; the body pure white, wings and tail a light cream color (no date given).[1] Aug., 1890 (?), Woodbridge, a remarkable albino taken; its bill, tarsi, toes, nails, and the entire plumage being pure white, except that the wings and tail were tinged with sulphur yellow. The eyes were deep pink. (In possession of J. M. Blake, New Haven.)

**Myiarchus crinitus** (Linnæus). Crested Flycatcher.

A tolerably common summer resident of orchards and woodland from the middle of May until August. In Litchfield it is rare (E. S. W.).

Earliest record. New Haven, May 1, 1906; Portland, May 4, 1896.

Latest record. New Haven, Sept. 18, 1903.

Nest. An old woodpecker's hole or other cavity, usually from 7 to 15 feet from the ground; in an apple tree.

Eggs. 3-6; early in June.

Nesting dates. Earliest record. May 27, 1896, six eggs (L. B. B.). Latest record. June 18, 1892, five eggs (J. C. A. M.).

Unusual record. May 27, 1889, Northford, set of seven eggs (A. M. Linsley).[2]

A nest of this species was once found by Mr. W. R. Nichols built somewhat like that of a Kingbird on the branch of a tree. This is very unusual, as this species practically always occupies a cavity in a tree.

**Sayornis phœbe** (Latham). Phœbe.

A common summer resident, arriving the last of March and remaining until October.

Earliest record. New Haven, March 20, 1894, March 14, 1902 (A. A. S.), Feb. 25, 1876 (Hall);[3] Portland, March 18,

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[1] *O. and O.*, v, 6, p. 47.

[2] *Oölogist*, vi, 12, p. 233.

[3] Merriam, Birds of Conn., p. 52.

1898, 1907; Hartford, March 13, 1898;[1] Jewett City, March 15, 1902.[1]

Latest record. New Haven, Oct. 18, 1904, Oct. 26, 1906 (E. S. W.); Portland, Oct. 14, 1891, 1893.

Winter records. New Haven, Dec. 25, 1909 (D. B. P., C. H. P., and A. W. H.); one seen, Dec. 21, 1905 — March 10, 1906, and Nov. 25, 1906 — Jan. 22, 1907 (A. A. S.).

Nest. On the pillar of a porch, the rafter of a shed, inside an abandoned house, in the cellar of a barn, under a bridge, on a ledge of rocks, under the overhanging edge of a bank, or in the upturned roots of a tree; nest of mud and moss, lined with horse-hair.

Eggs. 3-6; early in May.

Nesting dates. Earliest record. April 27, 1898, five eggs (L. B. B.). Latest record. July 10, 1882, six eggs (C. L. R.).[2]

Nests are occasionally placed in abandoned nests of the Barn Swallow, while one containing five eggs was found placed in an old Robin's nest on a girder in a barn, May 15, 1893, in Trumbull (Beers).

An unusual nesting site was noted by W. W. C., Portland, on "a brace under the guards of the steam ferry-boat running [at that time] between Middletown and Portland."[3] This nest was seen by J. H. S.

**Nuttallornis borealis** (Swainson). Olive-sided Flycatcher.

A rare spring and fall migrant in late May and September.

Spring records. May 24, 1892, New Haven, male taken (Hedges, in coll. of L. B. B.); May 24, 1893, New Haven, female taken (A. H. V.); May 23, 1900, May 23, 1902, and May 19, 1909, New Haven, two taken, another seen (L. B. B.).

Fall records. Aug. 5, 1874, Suffield, male taken (Shores);[4] Oct. 18, 1875, New Haven, one seen (Merriam);[4] Aug. 27, 1903, Danbury, young female taken, and pair with three young seen several times during summer of 1903 (Hamlin); Sept. 13, 1904, New Haven, young female taken (L. B. B.); Aug. 31, 1904,

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[1] *Bird-Lore,* x, 5, p. 210.

[2] *O. and O.*, xvii, 5, pp. 77-8.

[3] *O. and O.*, vii, 23, p. 183.

[4] Merriam, Birds of Conn., p. 53.

Sept. 8, 1906, New Haven, seen (L. B. B.); Sept. 15, 1905, Litchfield, one taken (E. S. W.).

**Myiochanes virens** (Linnæus). Wood Pewee.

A common summer resident of woodlands and shade trees from the latter part of May until late in August.

Earliest record. New Haven, May 10, 1899; Portland, May 6, 1879, 1905.

Latest record. New Haven, Sept. 30, 1903; Portland, Oct. 3, 1890.

Nest. In an orchard, a shade tree (frequently an elm), or in the woods, about 10 to 20 feet from the ground.

Eggs. 2-4; the latter part of June.

Nesting dates. Earliest record. June 8, 1884, one egg (E. H. E.). Latest record. July 12, 1903, three eggs (J. C. A. M.).

Flying young were seen by J. H. S. and L. B. B. in Salisbury on the unusually early date of June 16, 1904.

Sets of three eggs each on the same fork of the same limb of a certain tree were found by J. C. A. M., June 16, 1895, June 13, 1897, and June 19, 1898, with no nest there in 1896, and all three sets very different in their markings.

**Empidonax flaviventris** (W. M. and S. F. Baird). Yellow-bellied Flycatcher.

A rather rare spring and fall migrant in May, August and September, keeping in secluded nooks in young woodland as it passes through the state.

Spring migration. Earliest record. New Haven, May 16, 1888, 1900. Latest record, May 28, 1909.

Fall migration. Earliest record. New Haven, Aug. 15, 1907. Latest record, New Haven, Sept. 1, 1896, 1906; Sept. 17, 1875 (Merriam).[1]

At Stamford in late summer this bird is occasionally common, as Mr. Porter secured ten males between Aug. 17 and Sept 26, 1893.[2] Hoyt took one at Stamford, May 17, 1890, and L. B. B., one, May 25, 1905; Eames, at Stratford, May 7, 1892, and at Bridgeport, May 27, 1892; W. E. T., one at East Hartford, Sept. 20, 1887, and three, May 23, 1892 (in coll. of J. H. S.).

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[1] Merriam, Birds of Conn., p. 59.

[2] *Auk*, xii, 1, p. 86.

**Empidonax virescens** (Vieillot). Acadian Flycatcher.

A rare summer resident of the southern border of the state; most common west of Stamford.

Earliest record. Stamford, May 17, 1890 (Hoyt).

Latest record. Stamford, Sept. 19, 1893 (Porter).

Spring records. June 24, 1874, Suffield, one taken (Shores);[1] May 17, 1890, Stamford, male taken (Hoyt, in coll. of L. B. B.); June 13, 1891, New Haven, male taken (Hedges, in coll. of L. B. B.); June 3, 1896, Guilford, male taken (L. B. B.).

Breeding records. Spring, 1875, Stamford, nest with five eggs (Hoyt); June 25, 1893, Greenwich, nest with three young (Voorhees);[2] June 2, 1894, Stamford, nest with three eggs (Rowell); May 20, 1903, Danbury, one pair, believed to be breeding, collected (Hamlin); June 2, 1906, Stamford, two nests with three eggs each, two other pairs of breeding birds, six old nests, found (Porter).[3] Mr. Porter describes the nests as always loosely thrown together with shreds hanging down from the sides; made of hemlock bark or grass.

**Empidonax traillii alnorum** Brewster. Alder Flycatcher.

A rare late spring and late summer migrant; regular summer resident in northwestern part of the state.

Spring migration. Earliest record. New Haven, May 26, 1909; Litchfield, May 27, 1905 (E. S. W.). Latest record. New Haven, May 31, 1904.

Fall migration. Earliest record. New Haven, Aug. 9, 1904. Latest record. New Haven, Sept. 7, 1905; Litchfield, Sept. 28, 1900 (E. S. W.).

Breeding records. June 22, 1886, Litchfield, nest with three well incubated eggs (L. B. W.); June 12, 1900, Warren, unfinished nest found, and a female, which would have laid in a few days, taken (A. H. V. and L. B. B.); June 13, 1905, Litchfield, three nests found, containing two sets of four eggs each and one of three eggs, nests in alders and a spruce, between 1 and 2 feet from the ground (E. S. W.); June 18, 1906, Litchfield, nest with four eggs (E. S. W.).

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[1] Merriam, Birds of Conn., p. 58.

[2] *Auk*, xi, 3, p. 259.

[3] *Auk*, xxiv, 1, p. 99.

**Empidonax minimus** (W. M. and S. F. Baird). Least Flycatcher.

A common summer resident of the orchards and shade trees of the state from early May to August.

Earliest record. New Haven, April 27, 1885; Portland, April 21, 1880; Hadlyme, April 26, 1899;[1] Hartford, April 27, 1902.[1]

Latest record. New Haven, Sept. 10, 1883, Oct. 1, 1907 (A. A. S.); Portland, Sept. 4, 1893; Litchfield, Oct. 1, 1890 (L. B. W.).

Nest. Of the 25 nests recorded in the last 5 years by J. H. S., 7 were in elms, 6 in willows, 6 in ash trees, 3 in wild cherries, and 3 in poplars; height from ground, 15-30 feet, except one at 5 feet and another at 40 feet; location, commonly an open swampy place, occasionally in thick growth. Building, May 15 — June 8.

Eggs. 3-5; early in June.

Nesting dates. Earliest record. May 23, 1906, two eggs (same nest, four eggs, May 26) (J. H. S.). Latest record. June 27, 1888, five eggs (E. H. E.).

## Suborder **OSCINES**. Song Birds.

### Family ALAUDIDÆ. Larks.

**Otocoris alpestris alpestris** (Linnæus). Horned Lark.

An irregular winter visitor from November to March; most common in small flocks along the coast.

Earliest record. New Haven, Nov. 2, 1906, Oct. 29, 1888 (L. B. W.).

Latest record. New Haven, April 15, 1882.

Inland records. March 22, 1875, Portland, two killed (one in coll. of C. H. N.); Dec. 3, 1889, East Hartford, two seen (W. E. T.); March 25, 1890, Portland, flock of thirteen seen (C. H. N.); March 27, 1899, about thirty seen, March 30, 1899, about twelve seen, Portland (S. R., one in coll. of J. H. S.); Oct. 27, 1903, Nov. 14, 1904, Litchfield, small flocks seen (E. S. W.).

A bird in which one tarsus had been broken and the foot had become fastened in the feathers of the abdomen was taken by L. B. B. in Guilford, Feb. 11, 1898.

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[1] *Bird-Lore*, x, 3, p. 117.

**Otocoris alpestris praticola** Henshaw. Prairie Horned Lark.

A rare winter resident in the state; breeding in Litchfield County.

Winter records. Feb. 1, 1889, Guilford, one female taken (L. B. B.); middle of Sept. to Oct. 10, 1900, Litchfield, a small flock seen, and specimens collected Oct. 7, 8 (L. B. W.); Feb. 6, 1904, Westville, small flock, one shot (Smith, in coll. of L. B. B.); Nov. 11, 1905, West Haven, flock of three taken (E. S. W. and L. B. B.); Jan. 3, 1910, West Haven, female taken (D. B. Pangburn, in coll. of L. B. B.).

Summer records. June 20, 1904, Salisbury, seen flying (J. H. S. and L. B. B.); July 31—Aug. 4, 1905, Goshen; April 22, June 2, July 8, 1906, Litchfield (E. S. W. and H. Sanford).

Breeding records. May 24, 1891, Torrington, set of four eggs with the female taken (Gath);[1] 1904, Watertown, pair breeding (Dutcher);[1] May 25, 1905, Litchfield, pair breeding (E. S. W.);[2] March 26, 1908, Danbury, nest with four eggs, hatched March 27 (Judd).[3]

Nest of this species thus described by Judd:[3] "A neat, well-made structure of fine, soft dead grass was placed in a hollow caused by the removal of a small stone on the gravelly western slope of a large round-topped sand hill."

**Otocoris alpestris hoyti** Bishop. Hoyt's Horned Lark.

A very rare accidental visitor.

Connecticut records. March 4, 1893, Bridgeport, one male and one female taken, somewhat nearer this form than a true *alpestris* (Eames, in coll. of Beers); Feb. 17, 1894, Stamford, male (Porter); March 7, 1903, Guilford, a male taken along with two typical *alpestris* males from a flock of Horned Larks (L. B. B.); Jan. 24, 1905, West Haven, male taken (A. Ganung, in coll. of L. B. B.); Nov. 3, 10, 1906, Guilford, two taken (E. S. W.).

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[1] H. K. Job, The Sport of Bird Study, p. 301.

[2] *Auk*, xxiii, 4, p. 461.

[3] *Bird-Lore*, x, 3, pp. 129, 130.

## Family CORVIDÆ. Crows, Jays, Magpies, etc.

### Subfamily GARRULINÆ. Magpies and Jays.

**Cyanocitta cristata cristata** (Linnæus). Blue Jay.

A common summer resident, a few wintering regularly; the majority going south early in October when there is a regular western flight, and returning in April.

Earliest record. New Haven, March 25, 1893;[1] Portland, Feb. 8, 1896, Feb. 12, 1900, 06, 07, 08.

Latest record. New Haven, Nov. 30, 1901;[1] Portland, Nov. 27, 1889.

Winter records. New Haven, Jan., 1882, 83, 84, 85, 1894, 95, 96, 98, 1900, 01, 02, 05; Dec., 1882, 83, 84, 1893, 95, 96, 1900, 03, 04, 05; Portland, Jan., 1881, Dec., 1881, 85, 87.

Nest. In a conifer or deciduous tree, usually near the border of dense brush or woodland; height from ground, 5-15 feet.

Eggs. 3-6; early in May.

Nesting dates. Earliest record. April 25, 1900, three eggs (L. B. B.). Latest record. July 1, 1882, six eggs (L. B. W.).

Migrating flocks observed near New Haven, April 1, 1896, Oct. 3, 1882, Sept. 30, 1890, Sept. 29, 1897, Sept. 29, 30, 1903 (L. B. B.).

### Subfamily CORVINÆ. Crows.

**Corvus corax principalis** Ridgway. Northern Raven.

Very rare.

Connecticut records. Dec. 28, 1889, West Haven, a bird, from its size, flight, and the marked emargination of its primaries, believed by L. B. B. to be a Raven, flew by him, about 125 yards away and 100 feet from the ground. As it uttered no sound, its identity is doubtful. Sept. 18, 1890, South Manchester, "a specimen of the American Raven was taken at this place" (O. J. Hagenaw).[2]

**Corvus brachyrhynchos brachyrhynchos** Brehm. Crow.

An abundant resident, gathering in flocks along the seashore in winter, but many going farther south in October.

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[1] Migrants.

[2] *O. and O.*, xv, 10, p. 156.

A regular migration westward occurs near the coast late in October, as has often been witnessed by L. B. B. and many others.

Roost. In the early eighties there was a larger winter roost in a pine grove in Hamden, containing probably 10,000 birds on the night of Feb. 22, 1882 (L. B. B.).

Nest. Large nest of sticks, dry weeds, etc., often lined with grapevine bark, usually close to the trunk of a chestnut or conifer, or in the top of a poplar, birch, or other tree; 12 to 80 feet from the ground.

Eggs. 4-7, commonly 4 or 5; middle of April.

Nesting dates. Earliest record. April 10, 1882, three eggs (L. B. B.). Latest record. June 12, 1892, four eggs (J. C. A. M.).

Unusual eggs. Six pinkish eggs were found in a nest near New Haven, May 8, 1884 (two in coll. of L. B. B.); light blue, almost unspotted eggs also occur in nests in which the other eggs are normal; a single egg in a set of six found measuring only 1.20 by .87 inch, May 18, 1893, Stratford (J. C. A. M.); a set of four pinkish eggs is in the Wood collection at the Morgan Memorial, Hartford, taken at South Windsor (J. H. S.).

A set of seven eggs was collected in the spring of 1893 near New Haven (H. W. F.).

L. B. B. records a Crow found in New Haven, Sept. 1, 1906, with a peculiar hoarse voice, which upon examination was learned to be due to a profuse purulent rhinitis.

A cinnamon colored Crow is recorded from Groton, Aug. 20, 1879.[1]

**Corvus ossifragus** Wilson. Fish Crow.

A rather rare resident near the coast, and extending some distance up the larger rivers.

Distribution. Small colonies and isolated nests have been found near the shore of the Sound at Woodmont, Milford, and Stratford (J. C. A. M.); at Niantic (Hill); New Haven (L. B. B. and C. C. T.); Fairfield and vicinity (Eames);[2] various points in Fairfield County (Beers); along the Housatonic Valley, as far north as Gaylordsville (Eames); along the Connecticut River

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[1] *O. and O.*, vi, 7, p. 55.

[2] *Auk*, x, 1, p. 89.

(Canfield and Watrous). One was taken in North Haven, Feb. 20, 1902, by Mr. Harry Ludington (in coll. of L. B. B.).

Nest. Usually located in the small branches at the top of the tallest tree in the vicinity, at a height of 35-60 feet from the ground; the birds breed in single pairs or in small colonies, near the coast.

Eggs. 3-5; early in May.

Nesting dates. Earliest record. May 5, 1895, five eggs (J. C. A. M.). Latest record. June 3, 1894, two eggs (J. C. A. M.).

Breeding records. May, 1888, New Haven, three eggs (C. C. T.); May 12, 16, 1891, Fairfield, four and five eggs respectively (Eames);[1] June 3, 1894, two eggs (J. C. A. M.); May 5, 1895, five eggs (J. C. A. M.); May 4, 1900, four eggs, and May 19, 1906, five eggs (Beers); May 12, 1901, Niantic, colony with five, five, four, and three eggs, and four young (Hill); May 14, 1904, four eggs, May 21, 1904, four young, and May 10, 1905, two sets of five eggs (L. B. B.).

### Family ICTERIDÆ. Blackbirds, Orioles, etc.

**Dolichonyx oryzivorus** (Linnæus). Bobolink.

A common but decreasing summer resident from the last of May until August, most abundant in the northern part of the state.

Earliest record. New Haven, May 5, 1898; Portland, April 27, 1891. The usual arrival is between May 5 and 15 (average of 44 years' records, J. H. S.).

Latest record. New Haven, Sept. 25, 1895; Portland, Oct. 15, 1890.

Nest. Eggs deposited on the ground in a meadow.

Eggs. 4-6; early in June.

Nesting dates. Earliest record. May 25, 1897, six eggs (H. R. Buck). Latest record. June 20, 1887, four eggs (H. W. F.).

In the southern part of the state the Bobolink now breeds commonly only in the meadows bordering the larger salt marshes, as at Stratford and Hammonasset Point.

Mr. Buttrick notes[1] that, from observations of this species made at Woodmont, he believes the Bobolink is at times polygamous; also that the young leave the nest before they are able to fly, when they are cared for by the females.

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[1] *Bird-Lore*, xi, 3, pp. 125-6.

**Molothrus ater ater** (Boddaert). Cowbird.

A common summer resident from April to November; occasionally lingers to January and probably winters.

Earliest record. New Haven, March 19, 1901; Feb. 20, 1887 (L. B. W.); Portland, March 21, 1910.

Latest record. New Haven, Dec. 1, 1903; Portland, Oct. 22, 1877.

Winter records. Jan. 15, 1874, Jan. 16, 1875 (Grinnell);[1] Feb., 1886, Woodbridge (Augur); Jan. 11, 1887, East Hartford (W. E. T.); Jan. 17, 1889, Bridgeport (Eames); Dec. 11, 1894, Dec. 13, 1895, Portland (J. H. S.); Dec. 25, 1901, Jan. 10, 1902, North Haven (Ludington, in coll. of L. B. B.); Dec. 26, 1904, Stratford (H. W. B. and J. C. A. M.).

Nest. The Cowbird does not build a nest, but deposits its egg or eggs in the nest of another and usually smaller species, the Red-eyed Vireo, Yellow Warbler, and Oven-bird being most frequently selected.

The following table shows the distribution of the eggs as recorded by J. H. S. and L. B. B. in 119 nests examined. The numbers in the three columns are the numbers of nests of the species named containing, respectively, one, two, and three eggs of the Cowbird.

| | | | |
|---|---|---|---|
| Red-eyed Vireo | 16 | 4 | |
| Yellow Warbler | 16 | 1 | |
| Oven-bird | 11 | 2 | 2 |
| Wilson's Thrush | 7 | | |
| Redstart | 6 | 1 | |
| Indigo Bunting | 5 | 1 | |
| Field Sparrow | 5 | | |
| Phœbe | 3 | 1 | |
| Maryland Yellow-throat | 3 | 1 | |
| Song Sparrow | 3 | 2 | |
| Yellow-throated Vireo | 3 | | |
| Chestnut-sided Warbler | 3 | | |
| Prairie Warbler | 3 | | |
| Purple Finch | 2 | | |
| Scarlet Tanager | 2 | | |

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[1] Merriam, Birds of Conn., p. 45.

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|---|---|---|
| Wood Thrush | 2 | |
| Blue-winged Warbler | 2 | |
| Louisiana Water-Thrush | 1 | 1 |
| Yellow-breasted Chat | 1 | 1 |

One Cowbird's egg was found in one nest of each of the following species, viz., Orchard Oriole, Chipping Sparrow, Cedar Waxwing, White-eyed Vireo, Worm-eating Warbler, Black and White Warbler, Wood Pewee, and Brown Thrasher.

Other species recorded are Robin (J. C. A. M.), Towhee (J. C. A. M. and Beers), Bobolink (L. B. W.), Bluebird (A. A. S.).

Eggs. 1-3, per nest; about the last of May or early in June.

Dates. Earliest record. May 11, 1904, April 29, 1906, one in Phœbe's nest (A. A. S.). Latest record. Aug. 4, 1882, two in Red-eyed Vireo's nest (L. B. B.).

There can be little doubt that the Cowbird often injures and sometimes removes one or more of the eggs of the host. Frequently the rightful egg has been found (L. B. B.) to be pierced with small holes, and at least twice one lying on the ground outside the nest. On the average a nest containing an egg of this parasite will be found to contain one less egg of the species owning the nest than is normal to that bird.

Occasionally, as is well known, some of our smaller birds will build a false bottom to the nest covering the intruding egg, and lay their own above it. In a nest of the Yellow Warbler and one of the Chestnut-sided Warbler, each containing four eggs and an egg of the Cowbird buried in the bottom, found by J. C. A. M., it is certain that the Cowbird's egg was the first laid, as in each instance he had visited these nests a week earlier and had found the Cowbird's egg alone in each.

Although remaining in flocks practically all the year, Cowbirds seem to separate into pairs for a short time in the spring. At this time a single male may often be seen seated in some treetop, calling, while probably the female is looking for a nest in which to lay.

**Xanthocephalus xanthocephalus** (Bonaparte). Yellow-headed Blackbird.

Accidental.

Connecticut records. 1878 (?), New Haven (?), a female formerly in the collection of Dr. W. H. Hotchkiss and now in the collection of L. B. B. (without label, but Dr. H. informed L. B. B. that all of these birds were taken near New Haven, chiefly during the spring of 1878); July, 1884, Hartford, one in a flock of Red-wings shot (W. E. T.);[1] July, 1888, Stamford, female shot (E. K. Colbron).[2]

**Agelaius phœniceus phœniceus** (Linnæus). Red-winged Blackbird.

An abundant summer resident, occasionally wintering; the males arriving on the average more than a month in advance of the females.

Males. Average date of arrival, March 5-20. Earliest record. New Haven, Feb. 10, 1896, Feb. 19, 1887 (Hooker), Feb. 20, 1887 (L. B. W.); Portland, Feb. 26, 1906.

Females. Average date of arrival, May 1-10. Earliest record. New Haven, April 13, 1887; Portland, April 26, 1910.

Latest record. New Haven, Dec. 7, 1893; Portland, Nov. 23, 1906.

Winter Records. Jan. 15, 1874, Jan. 16, 1875 (Grinnell);[3] Dec. 28, 1882, Dec. 27, 1883, Guilford, small flocks (L. B. B.); Dec. 25, 1901, Jan. 10, 1902, North Haven, several collected (Ludington, in coll. of L. B. B.); Jan. 7, 1905, Falls Village, one seen (H. K. J.); Jan. 1, 1910, New Haven, several seen, one female taken (C. H. P.).

Nest. On a tussock of marsh grass, a clump of weeds, a bunch of cat-tails, royal fern, or in a low bush (alder).

Eggs. 2-5; the last of May.

Nesting dates. Earliest record. May 16, 1894, four eggs (J. C. A. M.). Latest record. July 2, 1881, three eggs (L. B. B.).

**Agelaius phœniceus fortis** Ridgway. Thick-billed Blackbird.

A very rare straggler from the West in the fall, occurring occasionally with the flocks of the other blackbirds in the roosts in the Quinnipiac Marshes.

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[1] *Auk*, iv, 3, p. 256.

[2] *O. and O.*, xiii, 12, p. 189.

[3] Merriam, Birds of Conn., p. 45.

Connecticut records. Dec. 25, 1901, one adult male, Jan. 10, 1902, young male and young female, Nov. 11, 1903, young male, Quinnipiac Marshes, North Haven (Ludington and L. B. B., in coll. of L. B. B.).

**Sturnella magna magna** (Linnæus). Meadowlark.

A common summer resident of the meadows and pastures; a number winter regularly, sometimes in large flocks in the salt marshes along the coast, and scatter about the country in the last of March or early April.

Nest. Eggs laid in a tussock of grass in a field, or under a piece of drift on a salt marsh.

Eggs. 4-6; the last of May.

Nesting dates. Earliest record. May 17, 1890, three eggs (J. H. S.); May 19, 1899, five eggs (J. H. H.); May 19, 1904, five eggs (L. B. B.). Latest record. July 2, 1888, five eggs (Beers); Aug. 14, 1883, four deserted eggs (L. B. B.).

One was heard singing as late as Oct. 22 (1892) by L. B. B.

**Icterus spurius** (Linnæus). Orchard Oriole.

A tolerably common summer resident along the coast from the middle of May until July, breeding as far up the Housatonic valley as Gaylordsville; breeds rarely inland, however.

Earliest record. New Haven, May 2, 1908; Portland, April 30, 1896.

Latest record. New Haven, July 30, 1896; Portland, June 16, 1904.

Nest. Usually in an apple or pear tree in an orchard; height from ground, 7-15 feet.

Eggs. 4-5; early in June.

Nesting dates. Earliest record. May 29, 1896, four eggs (L. B. B.). Latest record. June 28, 1904, four eggs (Perry); July 3, 1882, four young (L. B. B.).

Inland nesting records. June 2, 1885, Portland, nest with five eggs (J. H. S.); June 10, 1900, Gaylordsville, nest found (Austin and L. B. B.).

Unusual nesting site. Feb. 16, 1907, Portland, old nest in an elm, 40 feet from the ground (J. H. S.).

One bird has been seen by Mr. Williams in Winchester.[1] One seen in Danbury, May 4, 1905 (J. C. A. M.).

**Icterus galbula** (Linnæus). Baltimore Oriole.

An abundant summer resident of the orchards and shade trees of the roads and city streets, from May until August.

Earliest record. New Haven, May 2, 1894; Portland, April 30, 1888. Average of 40 years' records, May 6 (J. H. S.).

Latest record. New Haven, Sept. 13, 1885; Portland, Sept. 8, 1885.

Winter records. Nov. 15, 1885, Portland (J. H. S.);[2] Dec. 22, 1892, Portland (C. H. N.);[3] North Haven, Dec. 9, 1901 (found dead by Mrs. L. Hemingway).

Nest. Usually in an elm, poplar, or maple; 20-75 feet from the ground; built by the female, May 15 — June 10.

Eggs. 4-7; early in June.

Nesting dates. Earliest record. May 23, 1906, two eggs (J. H. S.); May 25, 1895, five eggs (H. W. F.). Latest record. June 21, 1882, one egg and three young (L. B. B.).

Abundance of species. Fifteen nests of this species were noticed in the trees bordering Quinnipiac Avenue in Montowese, in a distance of about two miles, March 3, 1893 (L. B. B.). Again, in a walk of about the same length on Whitney Avenue, New Haven, 35 nests were counted, almost all in elms, Jan. 9, 1901; but in the same walk on Feb. 17, 1908, only 10 nests could be found, showing the great decrease of this species near New Haven in recent years (L. B. B.).

**Euphagus carolinus** (Müller). Rusty Blackbird.

A common fall migrant in October; less common spring migrant.

Spring migration. Earliest record. New Haven, March 24, 1888, March 20, 1905, 1906 (A. A. S.); Portland, March 20, 1905. Latest record. New Haven, April 20, 1905, May 13, 1907 (C. H. Pangburn); Portland, May 11, 1908.

Fall migration. Earliest record. New Haven, Sept. 25, 1897, Sept. 15, 1897 (A. H. V.); Portland, Sept. 17, 1895. Latest record. New Haven, Nov. 22, 1900, Dec. 13, 1906 (A. A. S.), Dec. 25, 1911 (C. H. P.). Portland, Nov. 3, 1908; Litchfield, Nov. 24, 1906 (H. Sanford).

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[1] Job, The Sport of Bird Study, p. 302.

[2] *Auk*, iii, 1, p. 135.

[3] *O. and O.*, xviii, 3, p. 47.

**Quiscalus quiscula quiscula** (Linnæus). Purple Grackle.

A common summer resident of the pines and spruces about the towns and cities of the southern part of the state; breeds as far north as Bethel, Litchfield, and Portland.

Earliest record. New Haven, March 4, 1882, Feb. 19, 1902 (A. A. S.); Portland, Feb. 20, 1880.

Latest record. New Haven, Nov. 8, 1901; Portland, Nov. 8, 1892. These birds seem to migrate in two divisions, the first leaving between August 24 and 30, the second between Sept. 25 and Oct. 30 (J. H. S.).

Winter records[1]. Dec. 20, 1887, New Haven (L. B. W.); Dec. 28, 1895, Hartford (J. P. Hall); Dec. 12, 1907, New Haven (A. A. S.).

Nest. In a conifer, from 10 to 40 feet from the ground.

Eggs. 3-5; May.

Nesting dates. Earliest record. April 25, 1892, five eggs (J. H. S.), April 25, 1895, five eggs (H. W. F.). Latest record. June 8, 1887, five eggs (Watrous).

Unusual nest. A nest in the rushes of a marsh near Kent found by H. K. J. Very unusual, since all other nests recorded were in trees and usually at some distance from the ground.

By the latter part of June, the duties of nidification over, the birds assemble in flocks and frequent the tops of trees in the woods.

Intermediates between *Quiscalus quiscula quiscula* and *æneus* are found breeding at Portland.

**Quiscalus quiscula æneus** Ridgway. Bronzed Grackle.

A tolerably common summer resident in the northern part of the state, breeding in the conifers about the towns as far south as Portland. An abundant fall migrant in October and November and irregular spring migrant in the southern part of the state, and a common spring and fall migrant in the northern part.

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[1] Probably some of these winter records refer to *Quiscalus quiscula æneus.*

Spring migration. Earliest record. New Haven, March 25, 1898, Feb. 27, March 10, 1906 (E. S. W.); Portland, March 21, 1891. Latest record. New Haven, April 24, 1907.

Fall migration. Earliest record, New Haven, Oct. 6, 1903. Latest record. New Haven, Dec. 12, 1889; Portland, Nov. 3, 1908.

Winter records. Jan. 23, 1884, Hamden (Munson); Jan. 17, 1895, New Haven (L. B. B.); Dec. 15, 1907, Jan. 22, 1908, East Haven (F. F. Burr).

Summer records. July 8, 1886, Plymouth, adult female (Webb, in coll. of L. B. B.); July 3, 1907, Litchfield, one shot (E. S. W.)

Roost. In the fall, thousands, probably tens of thousands, of blackbirds roost in the broad beds of cat-tail rushes in the Quinnipiac Marshes, about six miles north of New Haven. Although there are hordes of Red-wings, Cowbirds, Rusty Blackbirds, and Purple Grackles in late October and early November, the Bronzed Grackles far outnumber any other if not all other species combined. The blackbirds assemble as early as Sept. 26 (1904), increasing steadily to a maximum number at the end of October, falling off to the middle of November, with a few lingering into December in an open fall.

Soon after daylight each morning, the blackbirds leave the rushes, the vast majority flying westward in two or three enormous flocks, each several thousand strong, curving back and forth in long sweeps across the sky, and disappearing over the high ground to the west. Later small scattering flocks fly to all points of the compass. Toward the latter part of the afternoon (4 o'clock) the flocks begin to return from the west, a few from other directions, settling at first in the trees, and then in the rushes, until by 4:30 or 5 o'clock all have settled there for the night. How far these flocks go to feed, L. B. B. has been unable to ascertain; but it must be many miles, for he has frequently seen flocks flying toward these marshes after 4 P. M. at various places eight or more miles away (*e. g.*, Yale field, Orange; Saltonstall heights, East Haven; West Rock Ridge, some miles north of Lake Wintergreen). They all go off to feed, so that, during the daytime in the fall, blackbirds of all species are rather rare in the immediate vicinity of New Haven.

In a swampy spot, grown up with bushes and small trees, in the Little River marshes, near Middletown, is a roost where thousands of blackbirds congregate. Here the Purple and Bronzed Grackles outnumber all other species in early November. (J. H. S.)

### Family FRINGILLIDÆ. Finches, Sparrows, etc.

**Hesperiphona vespertina vespertina** (W. Cooper). Evening Grosbeak.

A very rare accidental winter visitor; only recorded in recent years.

Connecticut records. Last week in February, 1890, Cobalt (Chatham), nine or ten seen, two killed, March 6, one male (Bailey, in coll. of J. H. S.);[1] March 2, 1890, East Hampton (Chatham), flock of 12-14 seen, one male killed (in coll. of H. E. Rich);[2] March 10, 1890, Gaylordsville (New Milford), female shot from flock of four or five (E. H. Austin);[3] April 12, 1911, Woodstock, male and female taken (in coll. of Wadsworth Atheneum, Hartford).

The following reports of the presence of this species in Connecticut have appeared in print. That of February, 1905, in Litchfield was investigated carefully by Mr. E. S. Woodruff, who decided the birds were not Evening Grosbeaks; and some of the other records seem open to question, as no specimens were collected. Feb. 1-14, 1905, Litchfield, flock of thirty (Hutchins)[4]; Feb. 5-22, 1907, Bristol, several seen (Bruen); Oct. 17, 1909, Talcott Mt., West Hartford, seen (St. John)[5]; Jan. 13, 1911, Canaan, flock of eight (Adam)[5]; Feb. 12, 1911, Talcott Mt., West Hartford, one pair seen (St. John)[5]; Feb. 13, 1911, Taftville, a flock of eight males and eighteen females seen (Werking)[5]; Dec., 1910 — April, 1911, Woodstock, flock of about seventy-five seen[6].

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[1] *Forest* and *Stream,* xxxiv, 10, p. 187.

[2] *Auk,* x, 2, p. 207.

[3] *Auk,* vii, 2, p. 211.

[4] *Bird-Lore,* vii, 3, p. 173.

[5] *Bird-Lore,* xiii, 2, p. 94.

[6] *Hartford Courant,* Apr. 4, 1911.

**Pinicola enucleator leucura** (Müller). Pine Grosbeak.

A rather rare and irregular winter resident from November to March; usually absent, but occasionally occurring in considerable numbers.

Earliest record. New Haven, Oct. 31, 1903; Portland, Nov. 1, 1903.

Latest record. New Haven, March 11, 1884; Portland, April 6, 1903.

Occurrence. New Haven, Feb., March, 1883 (G. E. V.); Jan., March, 1884 (L. B. B.); March, 1884 (L. C. S.); March, 1893 (L. B. B.); Jan., 1893 (H. W. F.); March, 1907 (L. B. B.).; Jan., Feb., 1896, large flights in New Haven and Stamford (L. B. B., Andrews, Hoyt); Oct., Nov., 1903, and winter, 1903-4, large flights, New Haven and Stamford (L. B. B., Hoyt). Portland, Feb., March, 1873, Nov., 1874 — March, 1875, Nov., 1875, Dec., 1877, 1878, Jan., 1881, Dec., 1882 — Feb., 1883, Jan. — March, 1884, Dec., 1887, Jan. — March, 1893, Nov., 1895 — March, 1896, Dec., 1896, Jan., 1898, 1900, Nov., 1903 — April, 1904, large flights, Nov., 1906, Nov., 1907 — March, 1908, large flights, Jan., 1909. Litchfield, Oct. 26 — Dec. 10, 1903, several small flocks, Nov., 1906 (E. S. W.). New Canaan, 1903-4, 1904-5 (Mrs. Neide, by W. H. H.). Clinton, Nov., 1903 (H. W. F.). Westbrook, Nov., 1903 (Hooker). Sharon, Jan., 1904 (Smith). Lakeville, 1903-4 (J. Truelove). Northford, Nov., 1906 (E. S. W.).

The above records show the irregularity of the occurrence of this species, some winters passing without a record, and other winters having several. It further shows the two greatest flights, the winter of 1895-6, and 1903-4, the latter flight being recorded not only from New Haven and Portland, but also from Stamford, Litchfield, New Canaan, Sharon, Lakeville, Clinton, and Westbrook.

**Carpodacus purpureus purpureus** (Gmelin). Purple Finch.

A tolerably common summer resident; winters irregularly in the southern part of the state; most abundant during migrations in March, October, and November.

Spring migration. Earliest record. New Haven, March 9, 1904; Portland, March 10, 1894. Latest record. New Haven, May 15, 1907, 1909, May 25, 1907 (A. A. S.); Portland, May 30, 1889.

Fall migration. Earliest record. New Haven, Sept. 30, 1903; Portland, Oct. 8, 1894. Latest record. New Haven, Dec. 4, 1896; Portland, Dec. 9, 1884.

Winter records. New Haven, Jan. 4, Feb. 11, 1882, Dec. 28, 1883, Feb. 16, Dec. 29, 1884, Jan. 15, 1902, Feb. 24, 1912; Dec. 26, 1906 — Feb. 27, 1907, and up to Jan. 2, 1908 (A. A. S.). Portland, Dec. 12, 14, 21, 1877, Feb. 25, 1882, Feb. 29, 1884, Dec. 16, 1895, Feb. 3, 1896, Feb. 15, 1898, Jan. 23, 1909.

Nest. In a conifer; about 20 feet from the ground.

Eggs. 2-4; last of May.

Nesting dates. Earliest record. May 25, 1898, four eggs (J. H. H.). Latest record. July 8, 1884, two eggs (E. H. E.).

In Litchfield it is a common summer resident (E. S. W.), but it is rare at that season in the southern part of the state.

**Loxia curvirostra minor** (Brehm). Crossbill.

A rare and irregular winter resident between November and May.

Earliest record. New Haven, Oct. 11, 1906; Portland, Dec. 10, 1874.

Latest record. New Haven, May 12, 1883; Portland, May 2, 1907.

Occurrence. New Haven, May 12, 1883 (L. B. B.), April 14, 1884 (Trowbridge); March 3-9, 1888 (H. W. F., A. H. V.); Dec., 1889 (H. W. F.); Jan. 24-5, Feb. 1, 1890 (L. B. W.); Jan. 31, Feb. 14, 1895, Jan. 24, 1900, Nov. 4, 1903, Oct. 11 — Nov. 27, 1906 (L. B. B.); Dec. 25, 1906 (A. A. S.); Dec. 26, 1909 (C. H. P. and A. W. H.). Portland, Dec. 10, 1874, Jan 26, 1875, April 5, 1885, March 14, April 19, 1893, March 5, 1895, May 2, 1907. Bridgeport, Feb. 27, 1900 (Beers); Feb. 28, 1905 (Hamlin). Stamford, Feb. 10, 1890 (L. B. W.); Feb., 1893 (Porter). New London, winter, 1899-1900, large numbers (Hill). Cheshire, Jan., 1897 (Hotchkiss).

**Loxia leucoptera** Gmelin. White-winged Crossbill.

A rare straggler in winter.

Earliest record. New Haven, Nov. 3, 1906; Portland, Dec. 14, 1899.

Latest record. New Haven, Feb. 21, 1900, Feb. 26, 1888 (C. C. T.); Portland, May 12, 1900.

Connecticut records. Dec. 25, 1874, Jan. 27, 1875, Portland (J. H. S.); Jan., Feb., March, 1875, "not uncommon" (Merriam);[1] Dec. 7, 9, 1880, Norwich (Case, recorded by S. T. Holbrook);[2] Feb. 10-26, 1888, New Haven (Trowbridge); Dec., 1889, New Haven (H. W. F.); Jan. 27, 1894 (A. H. V.); (for winter, 1899-1900, see next paragraph); winter, 1903-4, New Canaan (reported by Hoyt); Nov. 1, 1906, Stony Creek (A. H. V.); Nov. 3 — Dec. 15, 1906, New Haven, common (L. B. B. and E. S. W.); Jan. 5 — Feb. 20, 1907, New Haven (A. A. S.); Feb. 27 — March 2, 1909, Middletown, two remained feeding in a spruce tree for several days (Bliss).

Unusual flight, winter, 1899-1900. A great flight of this species that visited New England this winter reached southern Connecticut, being frequently noted in several places: Portland, Dec. 14 — April 16, frequently seen, especially abundant in Jan. and Feb. (J. H. S.); New London, until March 1, in large numbers (Hill); Saybrook, early in Nov., through Dec. (J. N. C.); Guilford, Jan. 24 (A. H. V., L. B. B.); New Haven, common in flocks Feb. 6-21 (L. B. B.); Bridgeport, Feb. 27, hundreds seen (Beers); Stamford, March 10 (Hoyt). They obtained a large portion of their food from the fallen seeds of the hemlock, feeding among the dry leaves like sparrows.

**Acanthis hornemanni exilipes** (Coues). Hoary Redpoll.

Connecticut record. Nov. 24, 1906, East Haven, an adult female shot from a flock of common Redpolls by L. B. B. in company with E. S. W.

**Acanthis linaria linaria** (Linnæus). Redpoll.

An irregular winter resident; formerly sometimes common; scarce between 1882 and 1906 in southern Connecticut.

Earliest record. New Haven, Nov. 24, 1906, Oct. 29, 1906 (A. A. S.); Portland, Nov. 27, 1889.

Latest record. New Haven, April 5, 1907 (A. A. S.); Portland, May 11, 1900.

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[1] Merriam, Birds of Conn., p. 35.

[2] *O. and O.*, vi, 4, p. 31.

Occurrence. Portland, Feb. 22, 1875, Dec. 6, 1878, Dec. 21, 1880, Dec. 30, 1882, Feb. 9-10, 1883, Dec. 9, 1884, March 29, 1888, Nov. 27, 1889, April 5, 1890, Jan. 30, 1896, Feb. 19, 1896, Dec. 6, 1899, May 11, 1900. New Haven and vicinity, 1866 (Whitney); Jan. 15, 22, 1879 (Woolsey, in Peabody Museum); Jan. 22, 1879 (Osborne, in coll. of L. B. B.); about Feb. 15, 1883 (Osborne); March 2, 1884 (Allen); April 1, 1890 (L. B. W.); Jan. 27, 1894 (A. H. V.); Feb. 27, 1900 (Beers); Oct. 29, 1906 (A. A. S.); Nov. 24, Dec. 8, 18, 1906, Jan. 22, 27, 1907 (E. S. W. and L. B. B.); abundant Dec. 12, 1906 — March 15, 1907 (A. A. S.); seen frequently, winter of 1908-9 (C. H. P., D. B. P., A. W. H.). Bridgeport, Nov. 22, 1889 (Lucas, in coll. of Beers). Fairfield, Feb. 22, 1900 (Beers). Stamford, Jan., 1889 (Camp, in coll. of L. B. B.). Stony Creek, Nov., 1902 (A. E. V.). Branford, Jan. 31, 1904 (Nichols). Litchfield, March, 1896 (Sanford); Nov. 29 — Dec. 1, 1906 (E. S. W.). Danbury, common, winter of 1908-9 (J. C. A. M.). Middletown, March 6, 1909 (flock appeared about two weeks before) (Bliss). Middle Haddam, Jan. 28, 1912 (G. N. Lawson).

**Acanthis linaria rostrata** (Coues). Greater Redpoll.

The only Connecticut record is as follows: Dec. 17, 1878, New Haven, two taken by Dr. W. H. Hotchkiss (in coll. of L. B. B.).

**Astragalinus tristis tristis** (Linnæus). Goldfinch.

An abundant resident, keeping in flocks from September to May.

Nest. Frequently in a maple in the streets of some village, or in some other tree, at from 5 to 30 feet from the ground.

Eggs. 4-6; late in July or early in August.

Nesting dates. Earliest record. July 1, 1900, five eggs (Hill). Latest record. Aug. 31, 1906, five eggs (A. A. S.).

**Spinus pinus** (Wilson). Pine Siskin.

An irregular winter resident from November until April; sometimes very abundant, but usually absent.

Earliest record. New Haven, Oct. 8, 1906; Portland, Oct. 15, 1908.

Latest record. New Haven, May 7, 23 (?), 1888, May 19, 1907 (A. A. S.); Portland, May 22, 1911.

Occurrence. New Haven. Nov., 1882, Dec., 1884, Oct., 1887 (L. B. W.), May, Oct., 1888, Oct., 1889 (L. B. W.), March, 1894, Feb., April, 1896, Jan., Feb., April, 1900, Oct., 1906, Jan., May, 1907, Nov., 1911; Portland. March, 1884, Oct., 1887 — May, 1888, Nov., 1889 — May, 1890, April, 1892, Dec., 1895 — March, 1896, Dec., 1899 — March, 1900, March, 1902, May, 1904, Feb., 1907, Feb. — May, 1908, Oct., 1908 — May, 1909, May, 1911, Feb.—April, 1912.

**Plectrophenax nivalis nivalis** (Linnæus). Snow Bunting.

An irregular winter resident from November to March, most frequent near the coast; occasionally in large flocks, but more often not more than a dozen birds together.

Earliest record. New Haven, Nov. 2, 1906, Oct. 22, 1889 (L. B. W.); Portland, Oct. 29, 1876.

Latest record. New Haven, March 8, 1882; Portland, March 20, 1875.

At Stamford it has been taken in September (Schaler), and as late as March 19, 1892 (L. H. P.).

Large flocks. Jan. 25, 1875, Portland, flock of 200 seen (J. H. S.); Feb. 15, 1883, Hamden, a flock that covered acres (Osborne); Jan. 18, 1884, Portland, flock of 150 seen (J. H. S.); Jan. 27, 1898, Orange, flock of 200 (L. B. B.); Jan., 1905, Danbury, flock of over 200 (J. C. A. M.).

**Calcarius lapponicus lapponicus** (Linnæus). Lapland Longspur.

A rare and probably accidental late fall migrant.

Connecticut records. Merriam[1] recorded (1877), that one was taken, Nov., 1874, at Suffield by Shores, others at New Haven (no date) by Nichols, and others at Portland by W. W. C. (reported by Grinnell); March 1, 1875 (approximately), Portland, one received, caught here (W. W. C.); Nov. 29, 1884, Saybrook, male (H. W. F., in coll. of Brewster); March 29, 1888, Saybrook, a male shot (W. E. T., in coll. of J. H. S.); Dec. 12, 1891, Stratford, male and female taken (Beers); Nov.

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[1] Merriam, Birds of Conn., p. 36.

11, 1892, West Haven, male captured (H. W. F.); March 4, 1893, Bridgeport, four males (Eames); April 2, 1893, West Haven (A. H. V., in coll. of L. B. B.); Nov. 10, 1893, West Haven, a male (A. H. V., in coll. of Porter); Dec. 30, 1893, Stratford, a female (Dunbar, in coll. of Beers); Nov. 22, 1895, West Haven, a male (A. H. V.); Oct., 1904, Winchester, flock of seven or eight seen by Williams (H. K. J.);[1] winter, 1904-5, North Bridgeport, three flocks seen (Hamlin); Feb. 12, 1905, Kent, one seen (H. K. J.); Jan. 21, 1907, New Haven, seven seen (A. A. S.).

**Poœcetes gramineus gramineus** (Gmelin). Vesper Sparrow.

Formerly an abundant summer resident of the upland meadows from April until October; now rare over most of the state, none being found in places along the coast where they were common a few years ago.

Earliest record. New Haven, April 3, 1888, March 23, 1907 (C. H. Pangburn); Portland, April 1, 1905, 1908; Bridgeport, March 14, 1902;[2] Jewett City, March 20, 1889.[2]

Latest record. New Haven, Nov. 3, 1897, 1906, Nov. 4, 1906 (A. A. S.); Portland, Oct. 21, 1890.

Winter records. Dec. 31, 1887, New Haven, one male taken (A. H. V.); Feb. 1, 1889, Guilford, one taken (L. B. B.); Feb. 17, 1902, Saybrook, two spending winter there (J. N. C.).

Nest. On the ground, usually in the grass of a dry and sandy field.

Eggs. 3-5; last of May.

Nesting dates. Earliest record. May 1, 1906, four eggs (A. A. S.); May 3, 1881, four eggs (J. H. S.). Latest record. July 26, 1894, three eggs (H. W. B.).

This species seems never to have recovered from the great freeze of 1895, when so many thousands of birds perished in the southern states, and has become rarer annually since that date.

**Passerculus princeps** Maynard. Ipswich Sparrow.

A rare migrant and still rarer winter resident, in the beach grass of the seashore from November to March.

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[1] Job, The Sport of Bird Study, p. 303.

[2] *Bird-Lore*, xiii, 2, p. 86.

Connecticut records. Nov. 4, 1875, New Haven, female taken (Merriam);[1] March 24, 1883, Madison, one taken (L. B. B.); Nov. 26, 1884, West Haven, one taken (L. B. B.); Nov. 12, 14, Dec. 31, 1887, West Haven, three males (A. H. V.); Jan. 2, 1888, Woodbridge [?], female (A. H. V.); Oct. 19, two, Oct. 22, one, 23, one, 30, one, 1889, West Haven (L. B. W.); Jan. 5, 1892, Bridgeport, male (Eames); Nov. 1, one, Nov. 3, two, 1892, West Haven (H. W. F.); Nov. 25, 1905, New Haven, male (E. S. W.); Oct. 22, 1906, New Haven (E. S. W.); Jan. 3, 1910, West Haven (A. A. S., in coll. of L. B. B.); Nov. 8, 1911, West Haven, one (L. B. B.).

**Passerculus sandwichensis savanna** (Wilson). Savannah Sparrow.

An abundant fall migrant in September and October throughout the state; a tolerably common spring migrant in April on the coast, rarer inland; a few breed at the borders of the larger salt marshes and on inland meadows; they very rarely winter.

Spring migration. Earliest record. New Haven, March 29, 1901, March 24, 1906 (E. S. W.), March 24, 1883 (L. C. S.); Portland, April 6, 1890; Hartford, March 31, 1888.[2] Latest record. New Haven, May 22, 1909; Portland, May 27, 1881.

Fall migration. Earliest record. New Haven, Aug. 27, 1897; Portland, Sept. 21, 1892, 1893. Latest record. New Haven, Nov. 21, 1904; Portland, Oct. 26, 1892; Hartford, Nov. 29, 1888.[2]

Winter records. Jan. 19, 1895, West Haven, male taken, Dec. 26, 1911, East Haven, male taken (L. B. B.).

Nest. In the grass of a meadow bordering the large salt marshes, as those at Hammonasset Point, the Stratford Marshes, and formerly the Quinnipiac Marshes.

Eggs. 4-5; early in June.

Nesting dates. Earliest record. May 30, 1887, four eggs (Watrous). Latest record. June 11, 1888, four eggs (H. W. F.).

This species is found as a tolerably common summer resident in Litchfield by L. B. W.

**Ammodramus savannarum australis** Maynard. Grasshopper Sparrow.

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[1] Merriam, Birds of Conn., p. 36.

[2] *Bird-Lore,* xiii, 3, p. 144.

A common summer resident from May to July, chiefly of the dry upper meadows, but breeding also to the borders of the salt marshes of the coast.

Earliest record. New Haven, April 22, 1888; Portland, May 5, 1879, 1902, 1904.

Latest record. New Haven, Aug. 6, 1896; Litchfield, Sept. 18, 1891 (E. S. W.); East Hartford, Oct. 21, 1885 (W. E. T.).

Nest. On the ground in a meadow.

Eggs. 4-6; the last of May.

Nesting dates. Earliest record. May 23, 1897, six eggs (J. C. A. M.). Latest record. Aug. 22, 1895, four eggs (H. W. B.).

This species has never been found at Stamford by either Hoyt or Porter.

**Passerherbulus henslowi henslowi** (Audubon). Henslow's Sparrow.

A summer resident; common locally in Litchfield County, rare elsewhere in Connecticut.

Earliest record. April 27, 1905, Litchfield (E. S. W.).

Latest record. Oct. 8, 1901, Litchfield (E. S. W.).

Records outside of Litchfield County. Danbury (Fairfield Co.): May 14, 1905, two seen; June 1, 1905, set of five eggs; May 6, 1906, and later, seen; 1908, a number seen (J. C. A. M.). Bridgeport (Fairfield Co.): April 30, 1903.[1] West Haven (New Haven Co.): Oct. 27, 1888, one found dead (L. B. W.). Northford (New Haven Co.): 1890, two pairs breeding there (A. M. Linsley).[2] Killingworth (Middlesex Co.): July 18, 1873, one killed (Hall).[3] Norwich (New London Co.): July 3, 1882, set of eggs found ("Hawk").[4] Eastford (Windham Co.): May, 1881, C. M. Jones records[5] that Henslow's Sparrows have been on the increase there during the past five or six years. Pomfret (Windham Co.): June 1, 1906, heard singing (L. B. B.). Windsor (Hartford Co.): May 24, 1906, male shot (E. S. W.).

Nest. On the ground among the ferns and grasses, composed of dry grass, loosely woven together.

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[1] *Bird-Lore*, xii, 1, p. 14.

[2] *Oölogist*, viii, 9, p. 180.

[3] Merriam, Birds of Conn., p. 37.

[4] *Young Oölogist*, i, 11, p. 154.

[5] *O. and O.*, vi, 3, pp. 17-18.

Eggs. 3-5; early in June.

Nesting dates. Earliest record. June 1, 1905, five eggs (J. C. A. M. and L. B. B.). Latest record. Aug. 6, 1879, three eggs (C. M. Jones).[1]

This species frequents hillside meadows and swamps partially overgrown with shrubbery.

**Passerherbulus caudacutus** (Gmelin). Sharp-tailed Sparrow.

An abundant summer resident of the salt marshes from May to October, often lingering into December and probably occasionally wintering.

Earliest record. New Haven, May 4, 1887, April 30, 1889 (L. B. W.).

Latest record. New Haven, Nov. 10, 1883, Nov. 12, 1892 (H. W. F.).

Winter records. Dec. 2, 1882, Dec. 31, 1885, Dec. 12, 1889, Guilford (L. B. B.).

Nest. In the salt grass, frequently under a little drift material.

Eggs. 3-7, usually 4 or 5; the last of May.

Nesting dates. Earliest record. May 21, 1890, nest with eggs (L. B. W.). Latest record. June 21, 1882, three eggs (L. B. B.). A set of 7 eggs taken, New Haven, May 31, 1897 (L. B. B.).

Partial albino records. Dec. 31, 1885, Guilford (L. B. B.); Oct. 12, 1900, Nov. 7, 1903, West Haven (L. B. B.); Oct. 24, 1904 (L. B. B.), Oct. 8, 1909 (L. C. S.), Quinnipiac Marshes, North Haven; Oct. 25, 1905 (E. S. W.), Oct. 14, 27, 1905 (L. B. B.), New Haven.

Another anomaly. A few of the feathers of the juvenal plumage on the upper parts remained adherent to the tips of the feathers of the first winter plumage, as the natal down usually does to the juvenal, in specimens of this species taken in West Haven, Oct. 12, 1900, Oct. 18, 1901, and Oct. 21, 1903 (L. B. B.).

A female hybrid between this species and the Seaside Sparrow (*Passerherbulus maritimus maritimus*) was collected near New Haven, May 1, 1890, by H. W. F. (now in coll. of Brewster).

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[1] *O. and O.*, vi, 3, pp. 17-8.

**Passerherbulus nelsoni nelsoni** (Allen). Nelson's Sparrow.

A tolerably common fall migrant in early October; a rare spring migrant the last of May; confined almost exclusively to the salt marshes of the coast, and the wild rice, or water oats, growing along the larger rivers.

Spring migration. Earliest record. New Haven, May 30, 1902. Latest record. New Haven, June 1, 1901.

Fall migration. Earliest record. New Haven, Sept. 14, 1904; Portland, Sept. 21, 1892. Latest record. New Haven, Oct. 29, 1904; Portland, Oct. 22, 1894; East Hartford, Oct. 30, 1891 (W. E. T.).

Unusual record. Litchfield, Sept. 28, 1906 (E. S. W.). (Inland, and at a distance from a large river.)

In large series of *P. nelsoni nelsoni* and *P. nelsoni subvirgatus*, and an equal number of *P. caudacutus,* in coll. of L. B. B., no intermediates can be found.

**Passerherbulus nelsoni subvirgatus** (Dwight). Acadian Sharp-tailed Sparrow.

A common fall migrant in October; and much rarer spring migrant the last of May, keeping very closely as a rule to the salt marshes of the coast, and the wild rice, or water oats, growing along some of the larger rivers.

Spring migration. Earliest record. New Haven, May 24, 1900, May 21, 1892 (H. W. F.). Latest record. North Madison, June 9 (Dr. J. Dwight, Jr.).[1]

Fall migration. Earliest record. New Haven, Sept. 27, 1900; Portland, Sept. 26, 1892; Lyme, Sept 25, 1896 (W. E. T.). Latest record. New Haven, Nov. 8, 1904; Portland, Oct. 21, 1893.

**Passerherbulus maritimus maritimus** (Wilson). Seaside Sparrow.

An abundant summer resident of the salt marshes from May until September.

Earliest record. New Haven, April 30, 1894, April 28, 1890 (H. W. F.).

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[1] *Auk,* iv, p. 236.

Latest record. New Haven, Oct. 19, 1893, 1900, Oct. 30, 1889 (L. B. W.).

Winter records. Dec. 30, 1882, Dec. 12, 1889, Guilford (L. B. B.); Jan. 18, 1888 (A. H. V.), Jan. 17, 1888, Nov. 17, 1892 (H. W. F.), New Haven; Dec. 17, 1884, West Haven (Webb).

Nest. In the salt grass.

Eggs. 3-5; last of May.

Nesting dates. Earliest record. May 16, 1894, four eggs (L. B. B.). Latest record. July 12, 1883, four eggs (J. N. C.).

Partial albinos. Oct. 30, 1889, New Haven (L. B. W.); Dec. 12, 1889, Guilford, male, the entire interscapular region, most of the scapulars, the entire lower parts, and scattered contour feathers in the rest of the plumage, white (L. B. B.); Nov. 17, 1892, Quinnipiac Marshes, female with many white feathers (H. W. F.).

**Zonotrichia leucophrys leucophrys** (J. R. Forster). White-crowned Sparrow.

A rather rare and irregular spring and fall migrant in May and October; more common in the fall.

Spring migration. Earliest record. New Haven, May 4, 1896; Portland, May 12, 1889, 1905. Latest record. New Haven, May 19, 1902; Portland, May 22, 1888.

Fall migration. Earliest record. New Haven, Sept. 29, 1903; Portland, Oct. 2, 1893. Latest record. New Haven, Oct. 26, 1905; Portland, Oct. 16, 1893.

Winter records. Nov. 28, Dec. 5, 1874 (Merriam);[1] March 20, 1875, Portland (J. H. S.).

During the fall of 1893 this species was frequently noted in the vicinity of Portland by J. H. S., and in the fall of 1903 near New Haven by L. B. B. Near New Haven it has been noted 19 times in 11 different years since 1881 by L. B. B. Other records outside of Portland and New Haven include the following: Stamford, May 12, 1890 (Hoyt), Oct. 8, 1892 (Porter); Litchfield, Oct. 10, 1891 (L. B. W.), Oct. 10, 1905 (Sanford); East Hartford, May 6, 1893, Oct. 16, 19, 1895 (W. E. T.); Danbury, May 21, 1905 (J. C. A. M.); Stratford, Oct. 14, 1891, 1892 (Eames).

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[1] Merriam, Birds of Conn., p. 40.

**Zonotrichia albicollis** (Gmelin). White-throated Sparrow.

A common spring migrant in April and May, and even more common fall migrant in late September and October; occasionally winters; rare summer resident.

Spring migration. Earliest record. New Haven, March 11, 1882; Portland, April 13, 1892. Latest record. New Haven, May 25, 1909; Portland, May 21, 1888.

Fall migration. Earliest record. New Haven, Sept. 13, 1904; Portland, Sept. 15, 1877. Latest record. New Haven, Nov. 20, 1907; Portland, Nov. 28, 1885.

Winter records. Jan. 6, 1882, Dec. 19, 1900, Guilford (L. B. B.); Jan. 1, 1886, Dec. 25, 1902, Feb. 7, 1903, Jan. 26, 1905, Portland (J. H. S.); Dec. 20, 1904, Woodmont (L. B. B.); abundant from Dec. 13, 1906, until spring of 1907, New Haven (A. A. S.); Dec. 25, 1909, New Haven (C. H. P. and A. W. H.).

Summer records. June 18, 1904, Salisbury (J. H. S. and L. B. B.) (?); July 8, 1905, Winsted (J. H. S.); June 26, 1906, Litchfield (E. S. W.).

**Spizella monticola monticola** (Gmelin). Tree Sparrow.

A common winter resident, arriving in November and leaving in March; very abundant during these two months.

Earliest record. New Haven, Oct. 16, 1900, Oct. 15, 1906 (A. A. S.); Portland, Oct. 10, 1890.

Latest record. New Haven, April 18, 1885, April 28, 1907 (A. A. S. and Pangburn); Portland, April 25, 1907, 1908.

The majority of these birds wintering in this state seem to be males. Their songs may be heard almost any mild day during the winter.

**Spizella passerina passerina** (Bechstein). Chipping Sparrow.

An abundant summer resident of orchards and gardens from April to October.

Earliest record. New Haven, April 2, 1904, March 28, 1902 (A. A. S.); Portland, April 5, 1892, 1910; Hartford, April 4, 1906;[1] Jewett City, April 5, 1907.[1]

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[1] *Bird-Lore*, xi, 6, pp. 256-7.

Latest record. New Haven, Oct. 31, 1902; Portland, Oct. 23, 1890, 1909; Hartford, Oct. 29, 1887;[1] East Hartford, Nov. 19, 1888 (W. E. T.).

Winter records. Feb. 23, 1877 (Grinnell);[2] Nov. 17, 1905, Light House Point, New Haven (E. S. W.); Dec. 8, 1906, New Haven (E. S. W.).

Nest. In a bush, vine or tree, 5-15 feet from the ground.

Eggs. 2-5; the last of May.

Nesting dates. Earliest record. May 10, 1896, four eggs (J. C. A. M.). Latest record. Aug. 23, 1883, two young (L. B. B.).

The Chipping Sparrow chooses some very odd places for its nest. It has been found built on the ground (L. B. B. and J. C. A. M.), in very low bushes just a few inches from the ground, on a dead limb (J. H. S.), etc.

A set of five eggs was taken near New London, May 29, 1897 (J. H. H.), and an unspotted egg in North Haven, May 23, 1883 (W. A. Robbins, in coll. of L. B. B.).

A female, many of whose breast feathers had dark central shafts — as in juvenal Plumage — was taken in East Haven, May 1904 (L. B. B.).

**Spizella pusilla pusilla** (Wilson). Field Sparrow.

An abundant summer resident from April to November; rarely wintering.

Earliest record. New Haven, March 29, 1898, March 14, 1902 (A. A. S.); Portland, March 28, 1910.

Latest Record. New Haven, Nov. 30, 1901; Portland, Oct. 26, 1892.

Winter records. Dec. 2, 1875 (Merriam);[2] Dec. 31, 1883, New Haven (L. C. S.); Jan. 31, 1885, New Haven (L. B. B.); Jan. 1, 1886, Portland (J. H. S.); Jan. 11, 26, 1886, Jan. 20-6, 1887, East Hartford (W. E. T.);[3] Jan. 5, 1891, Feb. 6, 11, 1892, New Haven (Hedges); Jan. 26, 1901, Dec. 18, 1906, New Haven (L. B. B.); Jan. 26, 1907, North Haven (E. S. W.); a small flock, Jan. 19 — Feb 4, 1906, Dec. 11, 1906 — Feb. 26, 1907, and Dec. 7, 1907, New Haven (A. A. S.).

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[1] *Bird-Lore*, xi, 6, pp. 256-7.

[2] Merriam, Birds of Conn., p. 39.

[3] *Auk*, iv, 3, p. 259.

Nest. On the ground near the borders of an open field, or 1 to 3 feet from the ground in a bush, frequently a juniper.

Eggs. 3-5; late in May.

Nesting dates. Earliest record. May 10, 1887, four eggs (H. W. B.), May 10, 1896, four eggs (J. C. A. M.). Latest record. July 29, 1900, three eggs (J. C. A. M.).

Partial albinos. Aug. 26, 1893, Stamford, entire plumage unusually pale, tail feathers almost white (Porter); May 2, 1899, New Haven, male with scattered white contour feathers (L. B. B.); Jan. 26, 1907, North Haven (E. S. W.).

**Junco hyemalis hyemalis** (Linnæus). Slate-colored Junco.

An abundant fall and spring migrant in October, November, and March, and common winter resident.

Earliest record. New Haven, Sept. 19, 1900; Portland, Sept. 15, 1903.

Latest record. New Haven, May 4, 1898; Portland, April 27, 1907.

Summer record. A young male in striped juvenal plumage taken at New Haven, July 27, 1903 (L. B. B.).

Partial albinos. A young bird having the crown and most of the wings and tail ashy white, taken at New Haven, Dec. 21, 1900 (L. B. B.). Birds with the greater primary coverts spotted with white have been taken near New Haven, Oct. 25, 1901, Nov. 10, 1903, and March 29, 1904 (L. B. B.).

**Melospiza melodia melodia** (Wilson). Song Sparrow.

An abundant summer and tolerably common winter resident, the great majority arriving early in March and leaving in November.

It winters regularly along the shores of the Sound, and was especially abundant near New Haven and Bridgeport in December, 1904.

Period of singing. Earliest record. Feb. 21, 1900. Latest record. Oct. 24, 1892.

Nest. On the ground, or in bushes and vines, 3-8 feet from the ground, usually partially covered with dry grass, weeds, or leaves, so as to be protected.

Eggs. 3-8; usually 4 or 5; the last of May.

Nesting dates. Earliest record. May 3, 1886, four eggs (Webb). Latest record. Aug. 24, 1883, three eggs (L. B. B.).

Unusual set. May 24, 1894, Stamford, eight deserted eggs found, all closely resembling one another (Porter).

Partial albino. A female with head and throat unspotted white, taken in Bridgeport, May 28, 1890 (Eames, in coll. of H. W. B.).

**Melospiza lincolni lincolni** (Audubon). Lincoln's Sparrow.

A rare fall and still rarer spring migrant in September and May.

Spring records. Merriam records[1] one taken in spring of 1875, at Saybrook, by J. N. C., three in spring of 1877, at Lyme, by J. G. Ely, and three more at Suffield, by E. I. Shores; April 24, 1886, East Hartford (W. E. T.);[2] May 18, 1890, Stamford Porter); May 23, 1892, East Hartford, male and female shot (W. E. T.);[3] May 15, 1900, New Haven (L. B. B.); May, 1901, Stamford (Hoyt); May 12, 1907 (A. A. S.).

Fall records. Sept. 21, 1885, East Hartford, female (W. E. T.); Sept. 15, 1887, Sept. 27, 1888, New Haven (H. W. F.); fall, 1891, Stamford (O. P. Hoyt); Sept. 21, 1892, Portland, one taken, Sept. 21, 27, 30, Oct. 3, 5, 1893, Portland, many seen, eight obtained by W. E. T. (in coll. of J. H. S.); Sept. 2, 1893, Stamford (Porter); Sept. 14, 24, New Haven (L. B. B.); Sept. 23, New Haven (A. H. V.); Sept. 25, 28, Oct. 26, 1895, New Haven (H. W. F.); Sept. 29, Oct. 13, 1903, New Haven (L. B. B.); Oct. 13, 1906, New Haven (E. S. W.); Oct. 6, 1911, New Haven (L. B. B.).

**Melospiza georgiana** (Latham). Swamp Sparrow.

A common spring and abundant fall migrant in April, May, September, and October; a tolerably common summer resident of the northern part of the state, but in the southern part known to breed only in the upper section of the Quinnipiac Marshes, where it is common, and near Bridgeport; very rare winter resident.

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[1] Merriam, Birds of Conn., pp. 38-9.

[2] *Auk*, iii, 4, p. 487.

[3] *Auk*, x, 2, p. 206.

Spring migration. Earliest record. New Haven, April 2, 1895, 1901; Portland, March 14, 1893. Latest record. New Haven, May 23, 1882, 1907 (A. A. S.); Portland, May 21, 1900.

Fall migration. Earliest record. New Haven, Sept. 16, 1904; Portland, Sept. 21, 1892, 1893. Latest record. New Haven, Nov. 11, 1903, Nov. 26, 1905 (E. S. W.); Portland, Nov. 28, 1885.

Winter records. Jan. 27, 1883, New Haven, one taken (W. Kent); March 7, 1888, New Haven, one taken (H. W. F.); Jan. 3, 1903, Bethel, one taken (R. C. Judd); Feb. 12, 1906, Portland (J. H. S.); Jan. 11, 1910, New Haven (C. H. Pangburn, in coll. of L. B. B.); Dec. 26, 1911, East Haven (A. W. H., D. B. P. and L. B. B.).

Nest. In a tussock of marsh grass in a fresh-water swamp.

Eggs. 4-5; the first part of June.

Nesting dates. Earliest record. May 18, 1890, four eggs (H. C. Judd). Latest record. June 22, 1907, four eggs (J. H. S.).

Partial albinos. Young female taken at New Haven, Oct. 13, 1903, has greater wing coverts white and much white in rest of plumage (L. B. B.); another female taken at Litchfield, Oct. 12, 1903, has back pure white and throat and breast chiefly white (E. S. W.).

**Passerella iliaca iliaca** (Merrem). Fox Sparrow.

A common spring migrant in March and early April, and a common fall migrant the last of October and November; wintering rarely.

Spring migration. Earliest record. New Haven, March 6, 1894, Feb. 25, 1906 (E. S. W.); Portland, March 2, 1883. Latest record. New Haven, April 18, 1885, April 25, 1907 (A. A. S. and Pangburn); Portland, April 26, 1875.

Fall migration. Earliest record. New Haven, Oct. 2, 1907, Sept. 16, 1895 (H. W. F.); Portland, Oct. 17, 1890, 1893. Latest record. New Haven, Nov. 30, 1901; Portland, Nov. 27, 1874.

Winter records. Jan. 5-6, 1882, Dec. 18, 1903, Jan. 9, 1905, Guilford (L. B. B.); Dec. 29, 1883, Bridgeport (C. K. Averill);[1]

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[1] *O. and O.*, ix, 2, p. 72.

Dec. 5, 1906, Dec. 24, 1907, New Haven (A. A. S.); Dec. 25, 1909, New Haven (C. H. P. and A. W. H.); Dec. 26, 1911, East Haven (A. W. H., D. B. P. and L. B. B.). Bridgeport, rare, but occurs in winter (Eames).

This species suffered severely in the winter of 1895, and not until about 1901 did it regain its former numbers. For example, J. N. C. wrote in March, 1902, that they were common at Saybrook for the first time in five years.

They often sing as they pass through the state, a large flock in full song having been noticed by L. B. B. on such winter dates as Nov. 11 (1903), Nov. 2 (1904), March 15 (1894).

**Pipilo erythrophthalmus erythrophthalmus** (Linnæus). Towhee.

A common summer resident from the latter part of April until the middle of October. A rare winter resident.

Earliest record. New Haven, April 24, 1885, April 14, 1904 (A. A. S.); Portland, April 21, 1909.

Latest record. New Haven, Nov. 3, 1883; Portland, Nov. 11, 1903.

Winter records. Jan. 22, 1876, Portland (J. H. S.); Feb. 11, 1882, Woodbridge (L. B. B.); Dec. 29, 1884, Guilford (L. B. B.); Jan. 16, 1899, Guilford (L. B. B.); Dec. 26, 1904, Stratford (J. C. A. M.); Jan. 16, 1905, East Haven (H. W. F.); Dec. 23, 1900, New Haven (A. A. S.).

Nest. Located on the ground in brush, under a bush, or at the foot of a tree; occasionally a foot or two from the ground in a small tree.

Eggs. 3-5; May 25-30.

Nesting dates. Earliest record. May 16, 1894, four eggs (J. C. A. M.). Latest record. July 21, 1895, three eggs (J. C. A. M.).

Probably eggs are laid at an even later date, as two males that were evidently breeding were taken by L. B. B., July 26, 1904. Others were heard singing, July 27, 1903, and Aug. 9, 1904; and a female still in juvenal plumage was collected, Sept. 8, 1903.

**Cardinalis cardinalis cardinalis** (Linnæus). Cardinal.

Connecticut records. Merriam[1] records that a specimen was found in 1874 in New Haven by Mr. Thomas Bostwick and was identified as a wild bird by Grinnell; May, 1885, Trumbull, a pair seen (Beers); a male in the collection of M. B. Tobey of Canaan may have been taken here, but is open to great doubt, since the collection contains a number of birds from the South and the West, and is not labelled; late in May, about 1900, Winchester, a male with full crest seen (Williams).[2]

**Zamelodia ludoviciana** (Linnæus). Rose-breasted Grosbeak.

A common summer resident from May until July.

Earliest record. New Haven, May 5, 1897, 1906, April 30, 1906 (A. A. S.); Portland, May 1, 1890, 1891, 1896, 1906, 1907. Average of 32 years' records, May 7 (J. H. S.).

Latest record. New Haven, Sept. 24, 1906, Sept. 28, 1892 (H. W. F.); Portland, Sept. 28, 1892.

Winter records. Nov. 25, 1874, New Haven (Merriam);[3] Nov. 15, 1904, Bridgeport, an adult male found dead, apparently killed by a recent storm (Beers). This was a peculiarly interesting specimen, in that the recently assumed winter plumage differed from that of the spring only in having a few brown tips to the feathers of head, back, throat, breast, and flanks, these tips hiding the black only on the back, and in having a conspicuous white malar stripe.

Nest. In the top of a slender tree, or bush, e. g., elder, willow, elm, in a thicket in swampy woods; 5-15 feet from the ground, occasionally higher.

Eggs. 3-5; early in June.

Nesting dates. Earliest record. May 19, 1891, four eggs (J. C. A. M.). Latest record. June 18, 1888, three eggs (E. H. E.); June 18, 1900, three eggs (L. B. B.).

Males hatched the previous year have occasionally in the spring many of the feathers of the throat and upper parts tipped with brown, and the rose-red of the breast prolonged almost to the bill. One in the collection of Porter has many of the feathers of the head and upper parts edged with rose-red.

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[1] Merriam, Birds of Conn., p. 44.

[2] Job, The Sport of Bird Study, p. 305.

[3] Merriam, Birds of Conn., p. 43.

In 1849, by request of the late Dr. Jno. C. Comstock, many of whose notes are published in this report, the name of the Rose-breasted Grosbeak was added to the list of song birds protected by the first act of the Connecticut legislature, and probably the first legislation in New England, for such a purpose. At that time the bird was scarcely known, but now it appears to be increasing in numbers throughout the state (J. H. S.).

**Passerina cyanea** (Linnæus). Indigo Bunting.

A common summer resident from May until August.

Earliest record. New Haven, May 8, 1897, 1908, May 3, 1888 (Webb); Portland, May 6, 1887, 1894; Litchfield, May 3, 1905 (E. S. W.).

Latest record. New Haven, Oct. 2, 1895; Portland, Oct. 16, 1893.

Nest. In a shrub or bush, rarely in the woods; 2-3 feet from the ground.

Eggs. 3-5; early in June.

Nesting dates. Earliest record, May 30, 1900, three eggs (J. C. A. M.). Latest record. Aug. 18, 1906, eggs, hatched Aug. 29 (A. A. S.).

Spotted eggs. Rare. Set of four, June 5, 1890, New Haven (Hedges, in coll. of L. B. B.); one, June 6, 1883, New Haven (Robbins and L. B. B.).

A female with the crown, rump, and upper tail feathers blue, and many blue feathers in other parts of the plumage, especially on the throat and breast, and the abdomen white, was collected by H. W. F. near New Haven, May 26, 1892.

Heard singing as late as July 27 (1903) and July 22 (1904) (L. B. B.).

**Spiza americana** (Gmelin). Dickcissel.

Formerly an abundant summer resident, but none have been taken in Connecticut in many years.

Up to 1840 this species was very abundant near New Haven; in fact it was almost as common as the English Sparrow is to-day, according to Professor Silliman of Yale, who thus reported it to Professor Verrill. A male and female of this species are in the

Peabody Museum, these specimens having come from the Yale Natural History Society, in a collection of mounted birds, some of which were collected by Linsley at Stratford, and the others probably near New Haven.

Hoyt records a specimen being seen near Stamford in the summer of 1904 by Miss Fessenden; but the possibility of mistaking a male English Sparrow for the Dickcissel has been more than once proved by experienced ornithologists.

### Family TANGARIDÆ. Tanagers.

**Piranga ludoviciana** (Wilson). Western Tanager.

A young male of this species was collected by H. W. Flint on Fair Haven Heights, in New Haven, Dec. 15, 1892. "It is not an escaped bird, as the feet and plumage clearly indicate."[1]

**Piranga erythromelas** Vieillot. Scarlet Tanager.

A common summer resident from May until September.

Earliest record. New Haven, May 1, 1907; Portland, May 3, 1908.

Latest record. New Haven, Oct. 10, 1901; Portland, Oct. 9, 1891.

Nest. In a tree in orchard or woodland, 5-20 feet from the ground.

Eggs. 3-5; early in June.

Nesting dates. Earliest record. May 28, 1898, four eggs (L. B. B.). Latest record. Aug. 10, 1909, three eggs (M. T. Smith).

Unusual eggs. Occasionally the eggs are very faintly and finely spotted, altogether lacking the usual bold markings; e. g., June 5, 1888, New Haven, set of four (Parsons); May 28, 1898, set of four (L. B. B.); June 2, 1903, Chester, one (Canfield); May 29, 1898, near New London, set of five (J. H. H.).

Variations in plumage of the males in the spring are many and interesting; e. g., one with the prevailing color of the plumage except the wings and tail coral-red, taken by A. H. V. and L. B. B., May 17, 1894; another with the prevailing color rufous, taken by L. B. B., July 9, 1904; others show patches of cadmium-yellow, or have occasionally the lesser coverts and bases of the greater coverts chrome-yellow or vermilion, or even more rarely the greater coverts tipped with vermilion. Adult males occasionally complete the fall moult before leaving for the south, specimens in full winter dress having been collected by L. B. B. the last of September.

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[1] *Auk*, x, 1, p. 86; also *O. and O.*, xvii, 12, p. 187.

**Piranga rubra rubra** (Linnæus). Summer Tanager.

Very rare summer visitant.

Connecticut records. Linsley recorded it from Stratford and New Haven. Merriam[1] noted that Shores killed one at Suffield, July 21, 1876; May 23, 1882, Whitneyville, female collected (L. C. S. in company with L. B. B.); April 8, 1886, New Haven, male taken (Hooker, in coll. of L. B. B.); April 28, 1893, Portland, a male which had died of exposure taken (Hurlburt, specimen examined by J. H. S.);[2] April 27, 1895, Old Saybrook, male taken (J. N. C.).[3]

## Family HIRUNDINIDÆ. Swallows.

**Progne subis subis** (Linnæus). Purple Martin.

Formerly an abundant summer resident from May until July; now rapidly decreasing throughout the state.

Earliest record. New Haven, April 20, 1889; Portland, April 4, 1903.

Latest record. New Haven, Sept. 2, 1885; Portland, Sept. 19, 1892.

Nest. Breeds in small colonies in martin-houses, though it has also been noted nesting in a hollow fence rail.[4]

Eggs. 4-6; early in June.

Nesting dates. Earliest record. May 21, 1880, four eggs.[4] Latest record. June 19, 1898, six eggs (Hill).

Formerly Purple Martins bred commonly around New Haven and even in the center of the city; but their numbers decreased in the eighties with the multiplication of the English Sparrows, so that they are now seldom seen there except as a rare migrant. In fact the last record in the breeding season for New Haven by L. B. B. is June 17, 1893, and he has seen none at any season there since 1905.

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[1] Merriam, Birds of Conn., p. 27.

[2] *Auk*, x, 3, p. 303.

[3] *Auk*, xii, 3, p. 306.

[4] *O. and O.*, v, 6, p. 47.

In Guilford Martins were abundant much later, but their numbers have markedly decreased, and now most of the martin-boxes are untenanted except by English Sparrows. Only one small colony there and another in Madison were found by L. B. B. in the summer of 1904. Hoyt reports that there was in 1905 at least one colony still breeding in Stamford. Colonies in Middletown and Portland were breeding in 1912. These birds should be encouraged by erecting boxes for them, care being taken to protect them from the English Sparrow, their worst enemy.

**Petrochelidon lunifrons lunifrons** (Say). Cliff Swallow.

A locally common summer resident from May until August; over most of the state only a tolerably common spring and fall migrant; decreasing, but not as rapidly as the Purple Martin.

Earliest record. New Haven, May 3, 1882, April 15, 1877 (Osborne),[1] April 21, 1906 (E. S. W.); Portland, May 19, 1905; Litchfield, April 30, 1905 (E. S. W.).

Latest record. New Haven, Sept. 18, 1895, Sept. 30, 1907 (A. A. S.); Portland, Sept. 14, 1877.

Nest. Breeds in colonies under the eaves of barns and outbuildings.

Eggs. 3-5; early in June.

Nesting dates. Earliest record. May 30, 1898, five eggs (Hill). Latest record. June 13, 1882, four eggs (L. B. B.).

Unusual eggs. In a set of five eggs collected in Meriden, May 31, 1885 (L. B. B.), one egg is pure white with a few purplish brown specks at the larger end, another pale cream-buff, heavily blotched with dull heliotrope-purple and mummy-brown at the base, while the other three are normal.

Albino. Aug. 22, 1902, Gaylordsville, one seen (Austin).

**Hirundo erythrogastra** Boddaert. Barn Swallow.

An abundant summer resident from May until August.

Earliest record. New Haven, April 13, 1887, April 7, 1888 (Webb); Portland, April 6, 1889.

Latest record. New Haven, Sept. 21, 1903, Oct. 29, 1888 (L. B. W.); Portland, Oct. 19, 1891.

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[1] Merriam, Birds of Conn., p. 30.

Nest. On a beam or against a rafter in a barn or shed, or more rarely under the eaves.

Eggs. 4-7; last of May.

Nesting dates. Earliest record. May 15, 1894, one egg (L. B. B.). Latest record. Sept. 3, 1892, five eggs slightly incubated (Dickerman of Danbury).[1]

A set of seven eggs was collected by L. B. B. in New Haven, May 24, 1893.

**Iridoprocne bicolor** (Vieillot). Tree Swallow.

An abundant spring, summer, and fall migrant in April and May, and from July to October; a rare summer resident, but more common in Litchfield county; still rarer winter resident.

Spring migration. Earliest record. New Haven, March 25, 1893; Portland, March 27, 1899. Latest record. New Haven, May 27, 1902; Portland, May 17, 1901.

Fall migration. Earliest record. New Haven, July 8, 1904; Portland, July 14, 1886. Latest record. New Haven, Nov. 21, 1900; Portland, Nov. 1, 1910.

Winter records. Winter, 1901-2, several spent the winter at Saybrook (J. N. C.), where about a dozen were seen Jan. 31, and 20 or 30 more by L. B. B., March 18, besides a probable straggler from that flock in Guilford, March 24. The stomachs of three collected were full of bayberries upon which they had lived during the winter.

Nest. Usually in a hollow tree in an old woodpecker's nest, 10-15 feet from the ground.

Eggs. 4-6; early in June.

Nesting dates. Earliest record. May 24, 1884, four eggs (J. H. S.). Latest record. June 20, 1898, five eggs (Hill).

In the spring there appear to be two flights, one chiefly of adult males early in April, the other largely of females about the middle of May. This swallow is the earliest migrant to return from the north, as many as 500 having been seen near New Haven as early as July 14 (1904) by L. B. B., and the last swallow to stay with us in the fall, several hundred having been seen by him on Oct. 6, 1903, and about a thousand on Oct. 24, 1898, and Oct. 13, 1905, which had been spending the nights in the rushes on the Quinnipiac marshes.

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[1] *O. and O.*, xvii, 11, p. 172.

**Riparia riparia** (Linnæus). Bank Swallow.

A summer resident from May until August, abundant locally where suitable banks occur along the larger rivers, but absent through much of the state except as a migrant.

Earliest record. New Haven, April 25, 1888; Portland, April 17, 1882.

Latest record. New Haven, Sept. 11, 1902, Sept. 23, 1906 (A. A. S.); Portland, Sept. 25, 1891.

Nest. In a narrow burrow several feet deep, excavated by the birds in a sand bank, usually on the bank of a river; generally composed largely of feathers.

Eggs. 2-6; the last of May.

Nesting dates. Earliest record. May 17, 1872, one egg, May 21, four eggs (J. H. S.); May 22, 1904, six eggs (J. C. A. M.). Latest record. June 14, 1893, three eggs (J. C. A. M.).

Unusual set. June 17, 1905, Litchfield, two incubated eggs (E. S. W.).

**Stelgidopteryx serripennis** (Audubon). Rough-winged Swallow.

A tolerably common summer resident of the southern border of the state from May until August; much rarer in the interior.

Earliest record. New Haven, May 1, 1897, April 30, 1907 (A. A. S.).

Latest record. New Haven, Aug. 13, 1903.

Unusual record. March 3, 1888, Stamford (Hoyt, in coll. of L. B. B.).

Nest. Located in a burrow in a sand bank, usually excavated by the birds themselves, wide enough to admit a man's arm, and somewhat broader than high, and from 3 to 5 feet long. Nest large and bulky and usually composed of sticks, weed stalks, grass, and leaves. Nests have also been found in empty pipes (A. A. S. and Case),[1] in an old Kingfisher's nest (E. S. W. and J. C. A. M.), in a crevice of the arch of a stone bridge (Porter, May 26, 1894), and in the drain-pipe of a bridge (Beers, May 30, 1904).

Eggs. 5-7; the last of May.

Nesting dates. Earliest record. May 22, 1904, seven eggs (J. C. A. M.). Latest record. June 24, 1900, five eggs (Hill).

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[1] *Oölogist*, xxii, 7, p. 108.

The bank selected for the nest is usually a small one, often in the woods or at the roadside, seldom near the water. Usually only one pair, and very rarely more than two, are found breeding at one place, but a colony of at least ten birds was found in New Haven, June 24, 1907 (A. A. S.). As a rule these swallows nest alone, though one pair was found breeding in a colony of Bank Swallows (J. C. A. M., 1904).

This Swallow has been seen in New Milford (E. H. Austin) and in Kent (H. K. J.).[1] A female, and three young just beginning to fly, seen at Portland, July 13, 1888, by J. H. S.

### Family BOMBYCILLIDÆ. Waxwings.

**Bombycilla garrula** (Linnæus). Bohemian Waxwing.

Connecticut records. Feb. 11, 1875, New Haven, one seen (?) (Smith);[2] Merriam further records[2] that Dr. Wood of East Windsor Hill shot one by accident while shooting into a flock of Cedar Birds (specimen now in Atheneum collection, Hartford); fall, 1899, Torrington, one shot from a flock of Cedar Birds (in possession of Hochstein).[1]

**Bombycilla cedrorum** Vieillot. Cedar Waxwing.

A tolerably common summer resident and irregular winter resident, often abundant in the migrations from March to May, and from September to November.

Earliest record. New Haven, March 2, 1904; Portland, March 7, 1878.

Latest record. New Haven, Nov. 22, 1900; Portland, Oct. 9, 1892.

Winter records. New Haven, Dec., 1881, Jan., Feb., Dec., 1882, Jan., 1900, 1902; Portland, Jan., 1884, Dec., 1885, Jan., 1886, Feb., 1887, 1893, 1895.

Nest. Most frequently in an apple or cedar growing in open country at from 10 to 15 feet from the ground; made of dead twigs, which the bird has once been seen to break off from the lower limbs of a tree.

Eggs. 4-5; late in June.

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[1] Job, The Sport of Bird Study, p. 305.

[2] Merriam, Birds of Conn., p. 32.

Nesting dates. Earliest record. June 11, 1881, one egg (L. B. B.); June 15, 1884, five eggs (Eames). Latest record. Aug. 23, 1874, four eggs (J. H. S.). Thirteen nests of this bird were found in one thicket of young maples at West Haven in August and September, 1906, and four other nests were discovered there after the leaves had fallen (A. A. S.).

A few of the rectrices are occasionally tipped with red in both sexes, and more rarely in the male many of the primaries; while the red tips of the secondaries are not unusual in juvenal plumage.

## Family LANIIDÆ. Shrikes.

**Lanius borealis** Vieillot. Northern Shrike.

A winter resident from November to March; probably occurring regularly, but seldom in large numbers, and not nearly as common at present as twenty years ago.

Earliest record. New Haven, Nov. 6, 1901; Portland, Oct. 26, 1888.

Latest record. New Haven, March 31, 1906, April 17, 1907 (A. A. S. and Pangburn), April 18, 1885 (F. W. Wentworth); Portland, April 4, 1873.

In March, before going north, the males occasionally mount to the top of some tree standing in rather open country, and warble in a harsh voice a song somewhat like that of a Bluebird. This singing has been watched by L. B. B. on March 28, 1883, and March 15, 1894, some of the notes on the latter occasion resembling those of the Chickadee.

**Lanius ludovicianus migrans** W. Palmer. Migrant Shrike.

A rare and irregular fall migrant and winter resident from August until February, occurring chiefly near the salt marshes along the coast.

Earliest record. New Haven, Aug. 18, 1903; Portland, Sept. 20, 1899.

Latest record. New Haven, Feb. 15, 1902; Portland, April 11, 1900.

Breeding record. Latter part of May, about 1893, Winchester, nest with five eggs found in an apple orchard (Williams, recorded by H. K. J.).[1]

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[1] Job, The Sport of Bird Study, p. 306.

Connecticut records. Nov., 1876, Portland, one taken (Goff, in coll. of W. W. C.); Aug. 22-4, 1882, Guilford, seen (L. B. B.); Jan. 30, 1883, Branford, male taken (Nichols, in coll. of L. B. B.); late Aug., 1880, one seen, and late Aug., 1885, two seen together, one shot, Bridgeport (Averill);[1] July, 1886, New Haven, male taken (H. W. F.); Aug. 15, 1888, North Haven, male taken (A. H. V., in coll. of Porter); Aug. 29, 1888, Bridgeport, young female (Averill, in Bpt. Sci. Soc.); Aug., 1892, New Haven (L. C. S., in coll. of L. B. B.); Sept. 18, 1895, North Haven, young female (L. B. B.); Sept. 20, Dec. 7, 1899, Portland, male (in coll. of J. H. S.); April 11, 1900, Portland, female (in coll. of J. H. S.); Feb. 25, 1901, Stamford, male (Hoyt); Sept. 18, 1901, Saybrook, one seen (J. N. C.); Jan. 15, 1902, Portland, female (J. H. S.); Jan. 20, 1902, North Haven, adult male (Ludington, in coll. of L. B. B.); Feb. 15, 1902, New Haven, female (L. B. B.); Oct. 2, 1902, Hamden, female (L. B. B.); Aug. 18, 1903, Branford, seen (L. B. B.); Oct. 6, 1903, North Haven, seen (L. B. B.); Nov. 6, 1903, Orange, female (Sherman, in coll. of L. B. B.); Sept. 16, 1904, Stratford, young male (Beers and Perry); Oct. 25, 1904, Middletown, female (in coll. of J. H. S.); Feb. 17, 1905, South Norwalk (Smith, recorded by J. A. Allen).[2]

## Family VIREONIDÆ. Vireos.

**Vireosylva olivacea** (Linnæus). Red-eyed Vireo.

An abundant summer resident of the woodland from the middle of May until September.

Earliest record. New Haven, May 4, 1882, May 2, 1906 (A. A. S.); Portland, April 26, 1896.

Latest record. New Haven, Oct. 10, 1901, Oct. 12, 1906 (A. A. S.); Portland, Oct. 8, 1890; Hartford, Oct. 25, 1900.[3]

Nest. Usually in a small tree or bush in dark woodland, 3 to 20 feet from the ground.

Eggs. 3 or 4; early in June.

Nesting dates. Earliest record. May 25, 1906, one egg, May 28, four eggs (J. H. S.); May 28, 1889, four eggs (C. F.

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[1] *Auk*, vi. 1, p. 74.

[2] *Auk*, xxii, 2, p. 211.

[3] *Bird-Lore*, xi, 2, p. 81.

Hedges). Latest record. Aug. 4, 1882, two eggs and two Cowbirds' eggs (L. B. B.).

This species is especially persecuted by the Cowbird; and, of 19 nests with 3 or more eggs recorded by L. B. B., 11 contained eggs of this parasite.

It sings constantly its monotonous ditty through the summer months, and has been heard repeating it by L. B. B. as late as Sept. 8 (1902) and Sept. 14 (1903).

**Vireosylva philadelphica** Cassin. Philadelphia Vireo.

A very rare spring and fall migrant.

Spring records. May 19, 1888, near New Haven, male taken (A. H. V.);[1] May 18, 1900, Westville, male taken (L. B. B.); May 17, 1905, Litchfield, female taken (E. S. W.).

Fall records. Sept. 21, 1893, Gildersleeve Island, Portland, male taken (S. R., in coll. of J. H. S.); Sept. 17, 1894, same locality, female taken (S. R., in coll. of J. H. S.); Oct. 4, 1899, Litchfield, female taken (E. S. W.); Sept. 14, 1905, East Haven, male taken (L. B. B.); Sept. 21, 1905, New Haven, female taken (L. B. B.).

**Vireosylva gilva gilva** (Vieillot). Warbling Vireo.

A common summer resident of the shade trees of the villages and cities, from May until September; but rare elsewhere in the state.

Earliest record. New Haven, May 2, 1899; Portland, April 26, 1908; Jewett City, April 20, 1898.[2]

Latest record. New Haven, Sept. 14, 1903, Sept. 19, 1906 (A. A. S.); Portland, Sept. 17, 1895; Litchfield, Oct. 1, 1890 (L. B. W.).

Nest. High in an elm or maple; occasionally in an apple tree.

Eggs. Usually 4; early in June.

Nesting dates. Earliest record. May 26, 1895, four eggs (H. R. Buck). Latest record. June 14, 1876, four eggs (J. H. S.).

This bird has been heard singing as late as Sept. 12 (1885) and Sept. 14 (1903) (L. B. B.).

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[1] *O. and O.*, xiii, 7, p. 103.

[2] *Bird-Lore*, xi, 2, p. 79.

**Lanivireo flavifrons** (Vieillot). Yellow-throated Vireo.

A tolerably common summer resident of the orchards, shade trees, and more open woodland, from May until August.

Earliest record. New Haven, April 27, 1886; Portland, April 26, 1889.

Latest record. New Haven, Sept. 20, 1900, Oct. 12, 1906 (A. A. S.); Portland, Sept. 21, 1893.

Nest. In tall tree, 12 to 35 feet from the ground.

Eggs. Usually 4; early in June.

Nesting dates. Earliest record. June 6, 1900, three eggs and one Cowbird's egg (L. B. B.). Latest record. June 17, 1893, four eggs (H. W. F. and L. B. B.); July 10, 1894, one young and one spoiled egg (L. B. B.).

J. H. S. notes that this species and *Vireosylva gilva gilva* usually migrate together.

**Lanivireo solitarius solitarius** (Wilson). Blue-headed Vireo; Solitary Vireo.

A common fall and much rarer spring migrant in early May and October; very rare summer resident.

Spring migration. Earliest record. New Haven, May 3, 1909, April 20, 1892 (Hedges); Portland, April 18, 1908, Litchfield, April 25, 1905 (E. S. W.). Latest record. New Haven, May 8, 1907, May 12, 1891 (H. W. F.); Portland, May 9, 1882; Litchfield, May 26, 1905 (E. S. W.).

Fall migration. Earliest record. New Haven, Sept. 22, 1896; Portland, Sept. 28, 1899; Litchfield, Sept. 18, 1891 (L. B. W.). Latest record. New Haven, Oct. 18, 1888, Oct. 23, 1906 (A. A. S.); Portland, Oct. 19, 1892.

Nest. In young tree or bush, from 5 to 10 feet from the ground.

Eggs. Usually 4; late in May and early in June.

Nesting records. Eastford, May 31, 1880, four young; June 6, 1885, two eggs and one Cowbird's egg; May 14, 1886, building, May 27, four eggs; May 27, 28, 1886, nests; June 10, 1886, nest, birds hatched and flown away (C. M. Jones).[1] Norfolk, June 23, 1893, four fresh eggs (W. E. T., in coll. of J. H.

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[1] *O. and O.*, xii, 2, p. 26.

S.). Bethel, June 9, 1895, nest with four eggs (Hamlin). Millington, May 30, 1899, nest with four eggs (J. H. S.). West Simsbury, June 8, 1894, nest with four eggs (Case).[1] Litchfield, late in June, 1907, male in full song (H. K. J. and E. S. W.);[2] shot, July 1, 1907 (E. S. W.)

**Vireo griseus griseus** (Boddaert). White-eyed Vireo.

A common summer resident in the southern part of the state from May until August; rarely breeds in Litchfield County.

Earliest record. New Haven, April 30, 1885; Portland, May 4, 1892.

Latest record. New Haven, Sept. 14, 1886; Sept. 20, 1906, 1907 (A. A. S.); Portland, Sept. 15, 1877.

Sept. 29, 1890, May 25, 1897, May 17, 1905, and July 12, 1906, are the only records from Litchfield (L. B. W. and E. S. W.); Lake Waramaug, June 10, 1900, one seen (L. B. B.).

Nest. Usually in a dense bush or thicket, from 1½ to 2½ feet from the ground.

Eggs. Commonly 4; early in June.

Nesting dates. Earliest record. May 26, 1887, four eggs (H. W. F.). Latest record. June 21, 1888, four eggs (H. W. F.); July 2, 1907, half-grown young (A. A. S.).

A set of unspotted eggs has been found near Bridgeport by J. C. A. M., and a single similar egg in a nest containing young at New Haven by L. B. B.

This bird has been heard singing its ludicrous song as late as Aug. 15 (1904) by L. B. B.

## Family MNIOTILTIDÆ. Wood Warblers.

**Mniotilta varia** (Linnæus). Black and White Warbler.

A common summer resident from early May until September; most abundant during the migrations in May and September.

Earliest record. New Haven, April 26, 1900, 1906, 1909, April 20, 1907 (Kedzie); Portland, April 23, 1909.

Latest record. New Haven, Oct. 4, 1901, Oct. 7, 1907 (A. A. S.); Portland, Oct. 6, 1892.

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[1] *Auk*, xiii, 4, p. 343.

[2] Job, The Sport of Bird Study, p. 306.

Nest. On the ground in woods with considerable undergrowth, though occasionally in the grass of an open field.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 20, 1895, five eggs (H. W. F.). Latest record. June 13, 1896, four eggs (J. H. S.); June 16, 1884, four young and one Cowbird (Prior).[1]

This warbler has been heard singing as late as July 22 (1904) by L. B. B.

**Protonotaria citrea** (Boddaert). Prothonotary Warbler.

The only records of this warbler for the state are, New Haven, Nov. 27, 1911, a young female found dead (W. F. Smith),[2] and Glastonbury, May 14, 1910, one seen plainly (L. W. Ripley).

**Helmitheros vermivorus** (Gmelin). Worm-eating Warbler.

A tolerably common summer resident along the coast; occurring rarely in the interior as far north as Kent and Portland; from the middle of May until early in August.

Earliest record. New Haven, May 6, 1904, May 3, 1892 (H. W. F.); Portland, May 6, 1896.

Latest record. New Haven, Aug. 22, 1903; Portland, June 18, 1896; Seymour, Sept. 30, 1888 (Eames).

Nest. On the ground among dead leaves under some small plant on a hillside in the woods.

Eggs. 3-6; the last of May.

Nesting dates. Earliest record. May 20, 1891, five eggs (Watrous). Latest record. June 19, 1890, five eggs (H. W. F.).

Occurrence. This species was reported as "rare" by Merriam[3] in New Haven, but since then (1877) has become tolerably common east of the city, though still rare to the west. It has been taken also at East Haven (H. W. F.), Pine Orchard (L. B. B.), Saybrook (J. N. C.), New London (Hill), Stamford (Porter), Bridgeport (Eames); inland, at Portland (J. H. S.), Seymour (Eames), Bethel (Judd), Danbury (J. C. A. M.), Kent (H. K. J.),[4] Suffield (Shores).[3]

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[1] *O. and O.*, ix, 9, p. 109.

[2] *Bird-Lore*, xiv, 2, p. 109.

[3] Merriam, Birds of Conn., p. 12.

[4] Job, The Sport of Bird Study, p. 306.

**Vermivora pinus** (Linnæus). Blue-winged Warbler.

An abundant summer resident of southern Connecticut from early May until August, outnumbering any other warbler with the possible exception of the Oven-bird; rarer farther north, though breeding at Portland and at Lake Waramaug in Litchfield County.

Earliest record. New Haven, May 2, 1899, April 30, 1908 (C. H. P.); Portland, May 2, 1902.

Latest record. New Haven, Sept. 16, 1904; Portland, Aug. 27, 1910.

Nest. Usually at the base of some small plant, often a goldenrod, where woods and meadow join, but also frequently in a small glade in the woods or smaller opening in brush land.

Eggs. 4-6; the last of May.

Nesting dates. Earliest record. May 20, 1896, five eggs (H. W. F.). Latest record. June 16, 1899, four eggs (J. C. A. M.).

Occurrence. From Bridgeport to New Haven the Blue-winged Warbler is a very abundant summer resident, Dr. Eames having seen at Bridgeport fully sixty males in song on May 9, 1889; but east of Branford it becomes rare, and has been seldom noticed by L. B. B. at Stony Creek or Guilford. At the mouth of the Connecticut they are again abundant. In the interior of the state they are likewise rather rare except in the spring migration, J. H. S. having noted its occurrence only once after June 13 (Aug. 27, 1910), and having observed only three nests; and E. S. W. having noted it only four times in Litchfield. At Danbury a male was taken April 27, 1908 (J. C. A. M.); and it has been seen in Kent in August, 1907 (G. E. Hix), at Lake Waramaug, June 10, 1900, and in Washington, May 30, 1907 (L. B. B.).

This species was found interbreeding with *V. chrysoptera*, at Portland, June 13, 1889,[1] and a male said to be mate of a female *V. chrysoptera* was taken with it in Woodbridge, May 23, 1898 (A. H. V., in coll. of L. B. B.).

Males showing an approach to *V. lawrencei* in having much black on lores and auriculars or one or two black feathers on throat have been taken at New Haven on May 23, 1902, June 5, 1905, May 24, 1907, and May 18, 1908 (L. B. B.).

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[1] *Auk*, vi, 3, p. 279.

**Vermivora chrysoptera** (Linnæus.) Golden-winged Warbler.

A rare summer resident in most parts of the state, very local in its distribution; a regular summer resident in small numbers at Portland.

Earliest record. New Haven, May 11, 1904, 1905, May 7, 1895 (H. W. F.); Portland, May 3, 1896; Litchfield, May 7, 1905 (E. S. W.). Average date of arrival at Portland for thirty-three years, May 14.

Latest record. New Haven, May 12, 1894, May 23, 1898 (A. H. V.); Portland, June 22, 1894; Litchfield, July 12, 1906 (E. S. W.); Suffield, July 7, 1876 (Shores);[1] New Haven, Aug. 24, 1912 (L. B. B.).

Occurrence. Bethel, breeding (Stetson, Judd, and Hamlin); Stratford (Eames); New Haven (Hedges, H. W. F., A. H. V., E. S. W., L. B. B.); Litchfield (E. S. W.); Danbury, breeding (J. C. A. M.); Kent (Job); Portland, breeding (J. H. S.). It has not been found at New London by Hill, nor at East Hartford by W. E. T., nor at Saybrook by J. N. C., though J. H. S. found one at Saybrook, May 30, 1877.

Nest. On the ground in brush land near a swamp.

Eggs. Usually 4 or 5; the last of May.

Nesting dates. Earliest record. May 29, 1895, five eggs (Hamlin). Latest record. June 21, 1894, four eggs (J. H. S.).

A nest containing five young with the male parent of this species and the female *V. pinus* was found at Bethel, June 11, 1905. June 16, the young had left the nest; but one was caught which had an olive-green back and yellow throat, breast, and lower parts, showing no black on throat or through eye (J. C. A. M. and R. C. Judd).

**Vermivora rubricapilla rubricapilla** (Wilson). Nashville Warbler.

A common spring and fall migrant in May and September; breeds in small numbers throughout the state, but more frequently in the northern part.

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[1] Merriam, Birds of Conn., p. 14.

Spring migration. Earliest record. New Haven, April 30, 1908; Portland, May 3, 1899. Latest record. New Haven, May 23, 1898, May 31, 1907 (A. A. S.); Portland, May 30, 1894, 1905.

Fall migration. Earliest record. New Haven, Sept. 14, 1905; Portland, Sept. 27, 1893. Latest record. New Haven, Oct. 9, 1907; Portland, Sept. 27, 1893.

Occurrence. Deep River, two nests (H. W. F.); New Haven, three nests (H. W. F.), one nest (L. B. B.); Bridgeport, one nest (Beers and Canfield); Seymour, breeds somewhat commonly, five or six pairs breeding regularly each year[1] (Eames); Kent, one nest (H. K. J.).[2] Although common in the spring at Litchfield (L. B. W. and E. S. W.) and at Portland (J. H. S.), no nests have been found at the former place and but one at the latter (June 4, 1889, four young, J. H. S.).

Nest. On the ground, usually just within the edge of the woods.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 30, 1890, five eggs (H. W. F.). Latest record. June 8, 1888, five eggs (E. H. E.).

**Vermivora celata celata** (Say). Orange-crowned Warbler.

A rare straggler from the West during the migrations.

Connecticut records. May 8, 1888, East Hartford, male shot, in company with Nashville Warblers (W. E. T.);[3] Nov. 11, 1893, Stamford, female (Porter); Oct. 1, 1906, New Haven, male taken (L. B. B.); Oct. 8, 1906, New Haven, young male taken (E. S. W.); Oct. 6, 1911, New Haven, one seen (L. B. B.).

**Vermivora peregrina** (Wilson). Tennessee Warbler.

A rare spring and fall migrant in May and September.

Spring records. June 8, 1875, Suffield, one shot (Shores);[4] May 24, 1876 (Osborne), May 26, 1876 (Bragg), New Haven;[4] May, 1876, Deep River (H. W. F.); May 26, 1888, Seymour (Eames); May 26, 1888, New Haven (H. W. F.); May 24, 1889, Bridgeport (Eames); May 20, 1891, New Haven (Webb); May 20, 1892, three, Stamford (Porter); May 23, 1892, East

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[1] *Auk*, x, 1, p. 90.

[2] Job, The Sport of Bird Study, p. 307.

[3] *Auk*, v, 3, p. 323.

[4] Merriam, Birds of Conn., p. 14.

Hartford (W. E. T.); spring, 1894, New Haven (W. C. Morgan); May 17, 1899, Portland (S. R.); May 16, 1900, Portland (J.H.S.); May 19-27, 1905, Litchfield, tolerably common, several being secured (E. S. W.); June 3, 1907, Kent (H. K. J.);[1] May 15-17, 1909, Portland (J. H. S.); May 23, 1910, Portland (J. H. S.).

Fall records. Sept. 24, 1887, New Haven (H. W. F.); Sept. 15, 1892, 1896, Litchfield (E. S. W.); Oct. 5, 1905, Sept. 8, Oct. 8, 1906, Oct. 9, 1907, New Haven (L. B. B.).

**Compsothlypis americana usneæ** Brewster. Northern Parula Warbler.

A common spring and fall migrant in May and September, breeding wherever it finds trees covered with Usnea.

Spring migration. Earliest record. New Haven, April 29, 1882, April 28, 1888 (L. B. W.), 1902 (A. A. S.); Portland, May 1, 1882. Latest record. New Haven, May 21, 1900, 1902; Portland, May 30, 1904.

Fall migration. Earliest record. New Haven, Sept. 1, 1903, Aug. 19, 1906 (A. A. S.); Portland, Sept. 21, 1893. Latest record. New Haven, Oct. 14, 1907; Portland, Oct. 18, 1899.

Winter records. Dec. 14, 1877, Deep River (H. W. F.); Nov. 28, 1901, New Haven, found dead after a severe storm by Prof. Reynolds (identified by L. C. S.).

Nest. Built in and of the Usnea, generally growing on cedars in the woods, also in swamp oaks, maples, hornbeams, etc., covered with Usnea; 3 to 20 feet from the ground.

Eggs. 3-8; usually 3 or 4; early in June.

Nesting dates. Earliest record. May 18, 1894, two eggs (L. B. B.). Latest record. June 29, 1886, four eggs (C. L. R.). Of 30 nests recorded by C. L. R.[2] between 1881 and 1887, 25 were found between June 1 and 12. The number of eggs in these 30 nests was as follows: 2 nests with 2 eggs, 7 nests with 3 eggs, 18 nests with 4 eggs, 1 nest with 5 eggs (May 31, 1887), 1 nest with 7 eggs (June 12, 1886), and 1 nest with 8 eggs (June 12, 1890).[3]

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[1] Job, The Sport of Bird Study, p. 307.

[2] *O. and O.*, xiii, 1, pp. 1-5.

[3] *O. and O.*, xvi, 4, p. 60.

These Usnea-covered trees have decreasd greatly near New Haven in the past twenty years, and with them have gone the Parula Warblers as summer residents.

**Dendroica tigrina** (Gmelin). Cape May Warbler.

A very rare spring and fall migrant.

Connecticut records. Spring, 1876, Suffield, not uncommon (Shores);[1] May 13, 1876, Portland, two adult males seen in the garden, one shot (J. H. S.); May 23, 1882, Lake Whitney, Hamden, male taken (L. B. B.); May 4, 1887, East Hartford, male taken (C. C. H.); Aug. 28, 1889, Bridgeport, one taken (W. H. Lucas);[2] Sept. 14, 1890, East Hartford, one seen (W. E. T.); May 13, 1891, East Hartford, male shot (W. E. T.); May 7, 1900, Kent, male taken (H. K. J.); spring, 1900, Saybrook, one taken and another seen (J. N. C.); May 8, 1905, Litchfield, male secured (E. S. W.); May 10, 1907, New Haven, one seen (A. A. S.); May 12, 1909, Cromwell, one picked up dead (in coll. of J. H. S.).

**Dendroica æstiva æstiva** (Gmelin). Yellow Warbler.

A common summer resident from May until August, frequenting the alders and willows along the streams.

Earliest record. New Haven, April 30, 1888, 1894, 1908, April 29, 1902 (A. A. S.); Portland, April 29, 1881, 1902, 1908.

Latest record. New Haven, Sept. 25, 1900, Nov. 7, 1907 (A. A. S.); Portland, Sept. 23, 1893.

Nest. In a bush or sapling in a swampy thicket, or less commonly in dry woods. Of 86 nests recorded by J. H. S., 1905-9, the distribution was as follows: 48 in elder; 7 in willow; 6 in alder; 2 each in ash, apple, and elm; 1 each in wild cherry, buttonwood, poplar, pear, and clematis; and 4 in small bushes. Height from ground varied from 3 to 30 feet, usually 3 to 6 feet. Building, May 12 to June 15; average, May 15-25.

Eggs. 3-5; last of May.

Nesting dates. Earliest record. May 22, 1899, four eggs (J. H. H.). Latest record. June 30, 1895, three eggs (J. C. A. M.).

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[1] Merriam, Birds of Conn., p. 17.

[2] *O. and O.*, xiv, 10, p. 160.

Double nests. Nests with a double bottom built over an intruding Cowbird's egg, found June 30, 1895, and May 27, 1900 (J. C. A. M.); June, 1893 or 1894 (Porter); June 2, 1898 (L. B. B.).

**Dendroica cærulescens cærulescens** (Gmelin). Black-throated Blue Warbler.

A common spring and autumn migrant in May and September; breeds tolerably commonly in Litchfield County at least as far south as Warren.

Spring migration. Earliest record. New Haven, May 5, 1894, April 30, 1908 (C. H. Pangburn); Portland, May 4, 1896; Hartford, April 29, 1891.[1] Latest record. New Haven, May 28, 1907, May 29, 1907 (A. A. S.); Portland, May 26, 1894.

Fall migration. Earliest record. New Haven, Sept. 11, 1902, 1903; Portland, Sept. 23, 1893. Latest record. New Haven, Oct. 11, 1906, Oct. 17, 1888 (H. W. F.); Portland, Oct. 9, 1883.

Nest. Just off the ground in thicket, usually of Kalmia; in woods.

Eggs. 3-5; early in June.

Breeding records. June 8, 13, 1874, two nests, and June 7, 1881, four eggs, Eastford (C. M. Jones);[2] June 8, 1900, Kent, nest with four eggs, female secured (L. B. B.); June 7, 1905, nest with five eggs, June 10, 1905, three eggs, Litchfield (E. S. W.).

The authors found this species tolerably common in Salisbury between June 16 and 20, 1904, frequenting wooded hillsides, overgrown with Kalmia.

**Dendroica coronata** (Linnæus). Myrtle Warbler.

A common spring and fall migrant in April, October, and November; a tolerably regular winter resident, especially near the coast.

Spring migration. Earliest record. New Haven, March 15, 1894; Portland, March 11, 1882. Latest record. New Haven, May 18, 1884, May 21, 1905 (A. A. S.); Portland, May 22, 1905; Litchfield, May 24, 1905 (E. S. W.).

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[1] *Bird-Lore*, viii, 6, p. 203.

[2] Merriam, Birds of Conn., p. 15. *O. and O.*, vi, 7, pp. 49-50.

Fall migration. Earliest record. New Haven, Sept. 21, 1903; Portland, Sept. 21, 1892, 1893; Litchfield, Sept. 14, 1905 (E. S. W.). Latest record. New Haven, Nov. 25, 1903; Portland, Nov. 1, 1890.

Winter records. New Haven or Guilford, Jan. 5, Feb. 8, 22, Dec. 12, 28, 1882, Jan. 1, 1883, Feb. 17 (?), 1886, Jan. 2, 1894, Jan. 22, 1896, Jan. 17, Feb. 11, 1898, Jan. 16, 1899, Jan. 24, Dec. 12, 1900, Jan. 15, 1902, Dec. 18, 1903, Feb. 27, 1904, Jan. 24, 1906 (L. B. B.); Portland, Dec. 15, 1882, Jan. 22, 1884, Dec. 29, 1892, Feb. 8, 1896, Feb. 23, 1903 (J. H. S.). Other records: Jan. 1, 1883, Portland (C. H. N.);[1] Jan. 29, 1905, New Haven (Stetson).

**Dendroica magnolia** (Wilson). Magnolia Warbler.

A common spring, and somewhat less common fall, migrant, in May and September; may breed in Litchfield County.

Spring migration. Earliest record. New Haven, May 7, 1888, May 3, 1886 (Webb); Portland, May 6, 1896. Latest record. New Haven, May 26, 1882, 1894, May 29, 1907 (A. A. S.); Portland, May 29, 1907, 1909; Litchfield, June 8, 1891 (E. S. W.); Salisbury, early in July, 1906 (?) (H. K. J.).

Fall migration. Earliest record. New Haven, Aug. 14, 1903; Portland, Sept. 21, 1893. Latest record. New Haven, Oct. 4, 1901; Portland, Sept. 28, 1892.

Partial albino. May 17, 1888, Seymour, a male with the entire top of the head, hind neck, and a broad eye ring white (Eames, in coll. of Beers).

**Dendroica cerulea** (Wilson). Cerulean Warbler.

A straggler to the southern border of the state; possibly a very rare summer resident.

Connecticut records: April, 1841, Stratford (Linsley);[2] June 12, 1875, Suffield, male taken (Shores);[3] May 10, 1888, Seymour, a female taken in a flock of Parulas (Eames);[4] May 12, 1900, Bridgeport, male taken (Beers, the two latter being in the collection of Beers).

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[1] *O. and O.*, viii, 4, p. 32.

[2] Merriam, Birds of Conn., pp. 15-16.

[3] *Bull. Nuttall Ornith. Club*, ii, 1, p. 21; recorded also by Merriam as above.

[4] *Auk*, v, 4, pp. 431-2.

**Dendroica pensylvanica** (Linnæus). Chestnut-sided Warbler.

A common summer resident from May until August; breeding more abundantly in the northern part of the state.

Earliest record. New Haven, May 2, 1899; April 30, 1908 (C. H. P.); Portland, April 28, 1908.

Latest record. New Haven, Sept. 14, 1895, Sept. 24, 1887 (H. W. F.); Portland, Sept. 5, 1892.

Nest. In a small bush, usually in a brush lot, occasionally in the woods; 1-4 feet from the ground.

Eggs. 2-4; early in June.

Nesting dates. Earliest record. May 23, 1896, four eggs (H. W. B.). Latest record. June 24, 1895, three eggs and one Cowbird's egg (Hamlin); July 22, 1904, young just out of the nest (L. B. B.).

This species has been found occupying a deserted Red-eyed Vireo's nest, the only part it had constructed being the lining of hair (Hamlin, June 22, 1895). A nest containing four eggs, and one of the Cowbird half buried in the bottom, was found, May 31, 1899 (J. C. A. M.).

Heard singing as late as July 10 (1888), by Eames.

A male taken in Litchfield, Aug. 17, 1892, by E. S. W. has a very slender bill, the maxilla being .5 inch long, and the mandible slightly shorter with a scoop-shaped tip.

**Dendroica castanea** (Wilson). Bay-breasted Warbler.

Usually a rare spring migrant and still rarer in the fall; occasionally common for a few days in May.

Spring migration. Earliest record. New Haven, May 10, 1900; Portland, May 12, 1905. Latest record. New Haven, June 6, 1882; Portland, May 26, 1882.

Fall records. Sept. 30, Oct. 17, 1876 (Osborne);[1] Sept. 25, 1890, Sept. 18, 1893, Portland (J. H. S.); Sept. 16, Oct. 5, 1887, East Hartford (W. E. T.); Sept. 26, 1893, Stamford (Porter); Sept. 6, 13, 1905, Litchfield (E. S. W.); Sept. 27, 1911, New Haven (L. B. B.).

Spring occurrence. New Haven, 1882 (common), 1884, 1886 (Webb), 1892 (Flint), 1900 (common), 1902, 1905, 1906, 1907

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[1] Merriam, Birds of Conn., p. 16.

(A. A. S.), 1909; Stamford, 1888 (L. B. B.), 1902, 1905 (Porter); Seymour, 1888 (Eames); Bridgeport, 1892 (Eames); Milford, 1893 (Eames); Portland, 1874, 1875, 1876, 1882, 1892, 1896, 1898, 1899, 1900, 1902, 1905, 1907, 1908, 1909. J. N. C. wrote in 1900 that in all his collecting he had only seen or taken two Bay-breasted Warblers at Saybrook.

**Dendroica striata** (J. R. Forster). Black-poll Warbler.

An abundant spring and fall migrant in the last of May and in September and October; their presence in the spring usually indicating the close of the warbler migration.

Spring migration. Earliest record. New Haven, May 13, 1904, April 29, 1908 (Pangburn); Portland, May 8, 1880. Latest record. New Haven, June 9, 1907, June 16, 1907 (A. A. S. and Barnum); Portland, June 17, 1907.

Fall migration. Earliest record. New Haven, Sept. 8, 1902; Portland, Sept. 14, 1908; East Hartford, Sept. 1, 1887, 1890 (W. E. T.); Litchfield, Sept. 7, 1905 (H. Sanford). Latest record. New Haven, Oct. 25, 1906; Portland, Oct. 25, 1887.

Oct. 30, 1906, New Haven, a pensioner was taken by L. B. B.

**Dendroica fusca** (Müller). Blackburnian Warbler.

A tolerably common spring and much rarer fall migrant in May and September; a few spending the summer in the pine groves of the northern part of Litchfield County, and doubtless breeding there.

Spring migration. Earliest record. New Haven, May 4, 1900, April 29, 1911 (A. W. H.); April 30, 1908 (Pangburn); Portland, May 6, 1891, 1896. Latest record. New Haven, May 26, 1900; May 30, 1907 (Moore); Portland, May 30, 1882.

Fall migration. Earliest record. New Haven, Sept. 13, 1905; Portland, Sept. 5, 1892; Stamford, Aug. 30, Sept. 4, 1893 (Porter); Litchfield, Aug. 29, 1892 (E. S. W.). Latest record. New Haven, Oct. 2, 1888 (H. W. F.); Portland, Sept. 28, 1875; Litchfield, Sept. 13, 1905 (E. S. W.).

Summer records. July, 1873, Lyme, a female taken (J. G. Ely);[1] June 25, 1879, Cornwall, male and female taken (Woolsey, in Peabody Museum); June 19, 20, 1904, Salisbury, two breeding males taken (J. H. S. and L. B. B.); June 16, 21, 24, 29, 1905, Litchfield (E. S. W.).

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[1] Merriam, Birds of Conn., p. 16.

**Dendroica virens** (Gmelin). Black-throated Green Warbler.

A common summer resident of the hemlock groves throughout the state from May until October; most abundant during the migration in May and September.

Earliest record. New Haven, April 21, 1886; Portland, April 27, 1886.

Latest record. New Haven, Oct. 20, 1908; Nov. 7, 1907 (A. A. S.); Portland, Oct. 21, 1890.

Nest. On the horizontal limb of a hemlock, less frequently in a birch or cedar; 3 to 30 feet from the ground.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 21, 1890, four eggs (H. W. F.). Latest record. June 20, 1894, four eggs (J. H. S.).

**Dendroica vigorsi** (Audubon). Pine Warbler.

A rather rare migrant, chiefly in April, and still rarer summer resident.

Spring migration. Earliest record. New Haven, April 10, 1890, March 30, 1907 (A. A. S.); Portland, April 2, 1882, Seymour, April 3, 1885 (Eames). Latest record. New Haven, May 3, 1882, May 12, 1880 (Woolsey); Portland, April 28, 1901.

Fall records. East Hartford, Sept. 26, Oct. 5, 1885, Sept. 9, Oct. 5, 1887 (W. E. T.); Portland, Sept. 21, Oct. 5, 1892; New Haven, Oct. 10, 1893 (L. B. B.), Oct. 4, 1906 (E. S. W.), Oct. 8-23, 1906 (?) (A. A. S.); Litchfield, Oct. 8, 1905 (H. Sanford, by E. S. W.).

Breeding records. July 4, 1893, East Haven, nest with young in a pine about 20 feet from the ground (H. W. F.); May 24, 1906, Windsor, a few evidently breeding (E. S. W.); June 1, 1909, East Haven, nest with three eggs in pitch pine (L. B. B.).

**Dendroica palmarum palmarum** (Gmelin). Palm Warbler.

A rare but probably regular fall migrant, the latter part of September.

Fall records. New Haven, Sept. 18, 1878, male taken (Woolsey, in Peabody Museum), Oct. 7, 1905, two (E. S. W.), Sept. 24, 1895, male, Oct. 1, 1895, male, Sept. 19, 1903, female, Sept.

26, 1905, two, Oct. 5, 1905, one female, Oct. 9, 1906, Sept. 26, 1907 (L. B. B.); Windsor, Sept. 4, 1893, one young taken;[1] Portland, Sept. 7, 1893, one shot in garden of J. H. S. by S. R.; Branford, Sept. 15, 1906, two (L. B. B.); East Haven, Oct. 5, 1907 (L. B. B.).

Spring record. May 5, 1888, Stamford, female taken (Hoyt).

**Dendroica palmarum hypochrysea** Ridgway. Yellow Palm Warbler.

A common spring and fall migrant in April and October; possibly occasionally wintering.

Spring migration. Earliest record. New Haven, April 10, 1889, March 24, 1890 (L. B. W.); Portland, April 4, 1910. Latest record. New Haven, May 13, 1882, May 14, 1907 (A. A. S.); Portland, May 8, 1893.

Fall migration. Earliest record. New Haven, Sept. 26, 1901, 1907; Portland, Sept. 29, 1893; Litchfield, Sept. 22, 1898 (E. S. W.). Latest record. New Haven, Oct. 30, 1907, Nov. 12, 1892 (H. W. F.); Portland, Oct. 31, 1908.

Winter record. Dec. 25, 1887, Woodmont, one taken (R. D. Camp).

**Dendroica discolor** (Vieillot). Prairie Warbler.

A common summer resident of the southern part of the state from May until July; less common farther north.

Earliest record. New Haven, May 2, 1882, 1899, April 27, 1907 (A. A. S.); Portland, April 27, 1888.

Latest record. New Haven, Oct. 17, 1904; Portland, Sept. 21, 1892.

Nest. In a small shrub, often a birch or bayberry, in a thicket, 1½ to 3 feet from the ground.

Eggs. 3-5; the last of May.

Nesting dates. Earliest record. May 27, 1894, four eggs and one Cowbird's egg (Morgan and L. B. B.). Latest record. June 25, 1888, four eggs (Eames).

Dr. Eames found it breeding commonly in Seymour in hazel bushes, and has heard it singing as late as July 10 (1888). It is very rare in Stamford (Hoyt and Porter). Mr. E. S. Woodruff found a few at Rainbow, Windsor, May 24, 1906.

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[1] *Auk*, xi, 2, p. 181.

**Seiurus aurocapillus** (Linnæus). Ovenbird.

An abundant summer resident of woodland from May until September.

Earliest record. New Haven, April 27, 1907, April 26, 1902 (A. A. S.); Portland, May 2, 1902, 1908; Hartford, April 26, 1893.[1]

Latest record. New Haven, Oct. 9, 1894; Portland, Sept. 28, 1901.

Nest. On the ground in the woods, covered; usually composed of leaves, strips of bark and vines, and weeds, and lined with fine grass and hair.

Eggs. 2-6, usually 3-5; the last of May.

Nesting dates. Earliest record. May 20, 1886, four eggs (J. H. S.); May 20, 1895, five eggs (Beers). Latest record. July 10, 1900, three eggs (L. B. B.).

A set of six eggs was collected near New Haven, May 30, 1891, by H. W. F.; a set of two eggs watched from May 31 to June 5, 1884, by Hamlin,[2] and another set of two incubated eggs watched from June 1 to June 5, 1896, by L. B. B.; a nest with two infertile eggs and five young birds was found June 16, 1883, by L. B. B.

This species is much persecuted by the Cowbirds, 11 out of 30 nests examined by L. B. B. containing eggs of this pest.

The Ovenbird has been heard singing as late as July 22 (1904) by L. B. B.

**Seiurus noveboracensis noveboracensis** (Gmelin). Water-Thrush.

A common migrant in May, August, and early September, frequenting the swamps and sluggish watercourses.

Spring migration. Earliest record. New Haven, May 6, 1899, May 2, 1888 (H. W. F.), May 2, 1906 (A. A. S.); Portland, April 27, 1908; Litchfield, May 1, 1905 (E. S. W.). Latest record, New Haven, May 29, 1907, May 31, 1907 (A. A. S.); Portland, May 30, 1905; Litchfield, June 3, 1905 (E. S. W.).

Fall migration. Earliest record. New Haven, Aug. 3, 1898; Portland, Aug. 17, 1886. Latest record. New Haven, Oct. 6,

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[1] *Bird-Lore*, viii, 3, p. 100.

[2] *O. and O.*, xvii, 7, p. 103.

1895; Portland, Oct. 3, 1890, 1893, 1894; Litchfield, Sept. 23, 1905 (E. S. W.).

**Seiurus noveboracensis notabilis** Ridgway. Grinnell's Water-Thrush.

A rare visitor during migrations.

Connecticut records. Sept. 7, 1904, Hamden, young female; Sept. 21, 1904, East Haven, young male; May 20, 1905, Orange, adult male; Aug. 25, Sept. 7, 1906, New Haven — all taken by L. B. B.; Aug. 29, 1907, Branford, one found dead (L. C. S., in coll. of L. B. B.).

**Seiurus motacilla** (Vieillot). Louisiana Water-Thrush.

A tolerably common summer resident from April until July, breeding throughout the state but most abundant near Saybrook.

Earliest record. New Haven, April 10, 1896; Portland, April 13, 1892.

Latest record. New Haven, Aug. 1, 1904.

Unusual record. Feb. 15, 1882, Deep River, one shot (H. W. F.).[1]

This species is rare in Litchfield County, but we have the following records: July 31, Aug. 1, 5, 9, 1893, Litchfield (E. S. W.); June 13, 1900, Warren, adults with young seen (L. B. B.); June 20, 1904, Salisbury, an adult (J. H. S. and L. B. B.); June 14, 1905, June 28, 1906, Mt. Tom, Litchfield County (E. S. W.).

Nest. In an upturned root, a mossy bank, or under the edge of the cut bank of a stream, usually within 1 to 5 feet of the water.

Eggs. 4-6; the middle of May.

Nesting dates. Earliest record. May 6, 1902, three eggs (J. C. A. M.); May 9, 1900, six eggs (J. H. H.). Latest record. June 10, 1894, four eggs (L. B. B.).

Heard singing as late as July 22 (1904) by L. B. B.

**Oporornis formosus** (Wilson). Kentucky Warbler.

Very rare summer visitant along the southwestern coast.

Connecticut records. May 30, 1888, West Stratford, a male shot (W. H. Lucas);[2] July 10, 1892, Greenwich, a female seen feeding a well-fledged nestling in the swampy woods; later, the same day, the male secured (C. G. Voorhees).[1]

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[1] *O. and O.*, vii, 19, p. 147.

[2] *O. and O.*, xiv, 4, p. 62.

**Oporornis agilis** (Wilson). Connecticut Warbler.

A tolerably common fall migrant in late September and early October; shy, and frequenting damp young woods with dense undergrowth; unknown in the spring.

Earliest record. New Haven, Sept. 12, 1904; Portland, Sept. 7, 1899; Litchfield, Sept. 1, 1893 (E. S. W.); East Hartford, Sept. 1, 1887 (W. E. T.).

Latest record. New Haven, Oct. 8, 1909, Oct. 13, 1906 (E. S. W.); Portland, Oct. 12, 1909; Litchfield, Oct. 11, 1900 (E. S. W.); Easton, Oct. 3, 1908 (H. W. B.).

This warbler is reported by E. S. W. as tolerably common in the fall at Litchfield. L. B. B. has a dozen or so records from New Haven, and J. H. S. an equal number from Portland. At other places it seems to be rather rare, Porter reporting it from Stamford only once (Sept. 28, 1893), Perry and Beers at Bridgeport once (Sept. 15, 1904), and Hoyt from Washington once (Oct. 10, 1904).

Adult males seem to be very rare, one being taken Sept. 27, 1886, by H. W. F., another Sept., 1893, by A. H. V. (in coll. of Porter), and one seen Oct. 5, 1901, by L. B. B. Taken at Portland, Sept. 23, 25, Oct. 5, 1893, by W. E. T. (in coll. of J. H. S.).

**Oporornis philadelphia** (Wilson). Mourning Warbler.

A rare late spring and fall migrant.

Connecticut records. Merriam[2] records the following: May, 1875, Milford, male and female killed (Grinnell); May 15, 17, 1876, New Haven (Osborn); May 24, 1876, New Haven, male (Bragg); May 25, 1876, New Haven, two males (Dayan); May 27, 1876, New Haven, several seen (Merriam); May 25, 1877, Savin Rock, New Haven, male (Merriam). Other records are: May 30, 1877, Saybrook (J. H. S.); May 30, 1879, Whitneyville, female (Woolsey, in Peabody Museum); May 23, 1882, Deep River, male (H. W. F., in Brewster collection); May 8, 1885, Litchfield, two seen (L. B. W.); Sept. 24, 1891, Litchfield, a female, the only fall record (E. S. W.); May 17, 18, 1892, New

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[1] *Auk*, x, 1, p. 86.

[2] Merriam, Birds of Conn., p. 23.

Haven, two males (H. W. F.); May 26, 1892, East Hartford, male taken (W. E. T.); May 26, 1893, Whitneyville, male seen (L. B. B.); May 26, 27, 1893, Portland, male taken (J. H. S.); May 31, 1898, Hamden, male taken (A. H. V., in coll. of L. B. B.); May 21, 1900, Kent (H. K. J.); June 17, 1907, Portland, adult male seen (J. H. S.).

**Geothlypis trichas trichas** (Linnæus). Maryland Yellow-throat.

A common summer resident, from May until October.

Earliest record. New Haven, May 2, 1899, 1908, May 1, 1902, 1907 (A. A. S.); Portland, April 29, 1908.

Latest record. New Haven, Nov. 3, 1883; Portland, Nov. 7, 1884.

Nest. On the ground under a plant, or a few inches from the ground in a tussock of grass or a skunk cabbage in a wooded swamp, or in a bush in a thicket.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 22, 1888, five eggs (C. L. R.).[1] Latest record. June 29, 1905, four eggs (E. S. W.).

This species has been heard singing as late as Aug. 1 (1904), by L. B. B.

A young male with bill twisted like that of a Crossbill taken in East Haven, Oct. 4, 1905 (L. B. B.).

**Icteria virens virens** (Linnæus). Yellow-breasted Chat.

A common summer resident from May until July, breeding in brush lots throughout the state, but most abundantly in the southern portion.

Earliest record. New Haven, May 2, 1899, 1908; Portland, May 6, 1896.

Latest record. New Haven, Aug. 17, 1894, Sept. 21, 1904 (?).

Unusual records. Oct. 3, 1896, New Haven, one just shot seen in a gun store (L. B. B.); Dec. 24, 1911, Jan. 1, 1912, South Norwalk (W. F. Smith).[2]

Nest. In a thick bush in brush lot, 1½ to 7 feet from the ground.

Eggs. 2-5, usually 4; the last of May.

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[1] *O. and O.*, ii, 1, p. 1.

[2] *Bird-Lore*, xiv, 2, p. 114.

Nesting dates. Earliest record. May 22, 1896, four eggs (L. B. B.). Latest record. July 7, 1888, four eggs (Eames).

Unusual sets. New Haven, June 9, 1899, set of two exceedingly small eggs (H. W. F.); Hamden, May 27, 1896, five eggs and two Cowbirds' eggs (L. B. B.).

**Wilsonia citrina** (Boddaert). Hooded Warbler.

A tolerably common summer resident of the southern part of the state from May to July; very rare inland.

Earliest record. New Haven, May 8, 1894; East Haven, May 4, 1886 (L. C. S.); Saybrook, May 2 (J. N. C.).[1]

Latest record. New Haven, July 22, 1904, Westville, Sept. 20, 1897 (A. H. V., in coll. of L. B. B.).

Inland records. Suffield (E. I. Shores);[2] Beacon Falls and Newtown (Eames); Winchester, 1900, nest with four eggs (Williams).[3]

Nest. Usually in the fork of a small Kalmia growing in the woods, 1-2 feet from the ground; composed of dry leaves, grape-vine bark, woolly and cottony material, and lined with fine new grass, grape-vine bark, root fibers, or horse-hair.

Eggs. 2-5, usually 4; the beginning of June.

Nesting dates. Earliest record. May 25, 1880, four eggs (J. N. C.).[1] Latest record. June 24, 1893, four eggs (H. W. F.).

Breeding localities. This species has been found breeding in Stamford (Porter), Bridgeport (Beers and J. C. A. M.), up the Housatonic as far as Beacon Falls and Newtown (Eames), near New Haven (H. W. F., A. H. V., L. B. B.), Saybrook (abundant, J. N. C.), Deep River (H. W. F., Watrous), New London (Hill).

This species frequents the dense Kalmia thickets of wooded hillsides. On account of its shy habits it is not as frequently seen as heard. The Hooded Warbler has been heard singing as late as July 22 (1904) by L. B. B.

**Wilsonia pusilla pusilla** (Wilson). Wilson's Warbler.

A spring and fall migrant in May and September; usually rather rare, and most often seen in the spring.

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[1] *O. and O.*, vi, 2, p. 9.

[2] Merriam, Birds of Conn., p. 25.

[3] Job, The Sport of Bird Study, p. 309.

Spring migration. Earliest record. New Haven, May 11, 1893, 1900; Portland, May 8, 1894, 1905. Latest record. New Haven, May 22, 1893, 1907, June 3, 1907 (A. A. S.); Portland, June 1, 1907.

Fall migration. Earliest record. New Haven, Aug. 27, 1907. Latest record. New Haven, Sept. 22, 1904; Portland, Sept. 27, 1893.

This bird frequents chiefly thick shrubbery in its passage through the state.

**Wilsonia canadensis** (Linnæus). Canada Warbler.

A common late spring migrant in May, and much rarer late summer migrant in August; undoubtedly breeds more or less regularly in the northwestern part of the state, although few nests have been taken.

Spring migration. Earliest record. New Haven, May 8, 1894; Portland, May 1, 1905. Latest record. New Haven, June 1, 1898, 1907, June 3, 1907 (A. A. S.); Portland, June 10, 1907; Milford, June 3, 1900 (J. C. A. M.).

Fall migration. Earliest record. New Haven, Aug. 12, 1904. Latest record. New Haven, Sept. 1, 1903; Portland, Sept. 1, 1892; Litchfield, Sept. 9, 1892 (E. S. W.); East Hartford, Sept. 16, 1885 (W. E. T.).

Summer records. June 15, 1885, June 9, 1891, Aug. 2, 1893, June 13, 14, 1905, Litchfield (L. B. W. and E. S. W.); June 15, 1894, near New Haven, a male with a female and young seen (A. H. V., the male taken by L. B. B.); July 3, 1896, Norfolk, young taken by W. E. T. (in coll. of J. H. S.); June 8, 1900, Kent (L. B. B.); June 11, 1900, Warren (L. B. B.); June 12, 1900, Romford (L. B. B.); June 18, 20, 1904, Salisbury (J. H. S. and L. B. B.); early July, 1906, Salisbury (H. K. J.).

Nest record. May 30, 1889, Northford, nest containing five eggs in a raspberry bush in a pasture, male identified while on the nest (A. M. Linsley).[1]

As all of the birds noted above in June kept closely to the locality in which they were first seen as long as they were observed, and as the males taken were certainly breeding birds, this species must be entered as a summer resident in this state. During this time this warbler frequents secluded ravines or wooded hillsides, with thick undergrowth of Kalmia, and carpeted with dry leaves.

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[1] *Oōlogist*, vi, 12, p. 233.

**Setophaga ruticilla** (Linnæus). Redstart.

A common summer resident from May until September, breeding in somewhat larger numbers in the northern part of the state.

Earliest record. New Haven, April 30, 1908; Portland, April 30, 1903.

Latest record. New Haven, Sept. 29, 1897, Oct. 5, 1907 (A. A. S.); Portland, Sept. 26, 1890.

Nest. Usually in a fork of the trunk of a small deciduous tree, from 10 to 20 feet from the ground. Building, May 20 to June 15.

Eggs. 3-5, usually 4; early in June.

Nesting dates. Earliest record. May 20, 1894, five eggs (H. W. F.). Latest record. June 27, 1883, three eggs (Eames).

Young males with the plumage somewhat brighter than the juvenal, with scattered black feathers on the throat, are common in the spring, and also occasionally noted in the fall (Sept. 17, 1900, Sept. 10, 1904, L. B. B.). L. B. B. is inclined to believe that this is the normal plumage of the male in the second year, and that it is assumed the first fall.

The Redstart has been heard singing as late as Aug. 15 (1904) by L. B. B.

### Family MOTACILLIDÆ. Wagtails.

**Anthus rubescens** (Tunstall). Pipit.

An abundant fall migrant in October and early November in the salt marshes; much rarer in the spring and in the interior of the state.

Spring migration. Earliest record. New Haven, April 2, 1898; Portland, April 8, 1909; Stamford, March 26, 1894 (Porter). Latest record. New Haven, April 24, 1889, May 16, 1888 (L. B. W.); Portland, May 8, 1905; Bridgeport, May 4, 1892 (Eames).

Fall migration. Earliest record. New Haven, Sept. 25, 1903; Portland, Sept. 27, 1892. Latest record. New Haven, Nov. 9, 1903, Nov. 23, 1907 (A. A. S.); Portland, Nov. 5, 1890.

Winter records. Samuels recorded that this species "remained throughout mild winters in southern New England."[1] Dec. 1, 1883, Dec. 31, 1885, Dec. 12, 1889, Guilford (L. B. B.).

### Family MIMIDÆ. Thrashers, Mockingbirds, etc.

**Mimus polyglottos polyglottos** (Linnæus). Mockingbird.

Very rare visitant.

Connecticut records. Linsley recorded it from Stratford and New Haven[2]; Milford (G. B. Grinnell)[2]; Suffield (Lester)[2]; Saybrook (J. N. C.)[2]; May 30, 1877, near New Haven (Osborne)[2]; Dec. 18, 1882, New Haven (formerly in coll. of L. C. S., seen in flesh by L. B. B.); June 20, 1884, Jewett City, nest with five eggs, June 28, second clutch of three eggs, female shot and identified (Prior)[3]; July 21, 1894, West Haven, one reported seen, in the New Haven *Journal and Courier;* Nov. 2, 1904, New Haven, one flew into greenhouse (J. Y. Stetson, seen by L. B. B.); June 9, 1907, Middletown, one seen (Cady); Nov. 30, 1910 — Feb. 9, 1911, West Hartford, one seen and identified by Mrs. L. A. Cressy; another seen the same winter (St. John)[4]; Feb. 8 — April 4, 1911, Portland, one seen by C. H. N.

The late Frank L. Burr, of the *Hartford Times,* once told me that about the time of the Civil War a pair of Mockingbirds nested in the meadow north of Avon St., Hartford. There was no question as to the identity of the birds, but the eggs were destroyed. A year or two later a pair had a nest quite near a house on Wethersfield Ave. in the same city, and in the vicinity of Armsmear, the residence of the late Mrs. Samuel Colt. This nest also had eggs which were destroyed. Gurdon Trumbull, the artist and ornithologist of Hartford, now dead, informed me that he remembered distinctly two or three pairs of these birds nesting, about 1860, in what was then known as Gillette's Grove, Hartford. He saw the birds and heard them sing. The eggs were taken by Mr. Trumbull and a boy friend, now a well-known actor and playwright. (J. H. S.)

**Dumetella carolinensis** (Linnæus). Catbird.

An abundant summer resident from May until September; winters accidentally.

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[1] Samuels, Birds of New England, p. 200.

[2] Merriam, Birds of Conn., p. 7.

[3] *O. and O.*, ix, 8, pp. 94-95.

[4] *Bird-Lore*, xiii, 2, p. 97.

Earliest record. New Haven, April 30, 1908, April 29, 1882 (L. C. S.); Portland, April 27, 1908.

Latest record. New Haven, Nov. 2, 1904, Nov. 4, 1874, 1875 (Merriam);[1] Portland, Oct. 12, 1909.

Winter records. Jan. 24, 1900, Guilford, one taken (A. H. V. and L. B. B.); Jan. 4, 1904, Berlin, bird which had spent winter, being fed by people, died of starvation (seen by J. H. S.); Dec. 24, 1911, South Norwalk (W. F. Smith).[2]

Nest. In a thicket, such as in an elder bush or grape-vine, or low willow, or tangle of bushes, 3 to 12 feet from the ground.

Eggs. 2-5, commonly 4; the last of May.

Nesting dates. Earliest record. May 17, 1887, nest with five eggs (J. N. C.).[3] Latest record. July 26, 1889, nest with three fresh eggs (W. I. C.);[4] Aug. 4, 1882, two young (L. B. B.).

Unusual nesting records. June 5, 1889, nest composed largely of paper (L. B. B.); May 20, 1893, nest with five eggs, built inside old Robin's nest (Beers); June 3, 1894, Branford, nest with six eggs (Nichols).

Mr. John Nichols records having seen eggs of this species spotted with red.

**Toxostoma rufum** (Linnæus). Brown Thrasher.

A common summer resident from May until September; winters accidentally.

Earliest record. New Haven, April 23, 1906, April 21, 1906 (A. A. S. and E. S. W.); Portland, March 28, 1879, April 20, 1910.

Latest record. New Haven, Oct. 24, 1911; Portland, Oct. 20, 1890; Branford, Nov. 29, 1911 (John Nichols).

Winter records. Shortly before Feb. 15, 1896, Bethel, collected by E. T. and H. C. Judd (in coll. of H. C. Judd); Jan. 17, Feb. 11 and 22, 1912, South Norwalk (W. F. Smith).[5]

Nest. Commonly on the ground at the foot of a stump, in a heap of brush, in bushes up to 4 feet from the ground, or very rarely higher in a tree, 12 feet from the ground, May 30, 1896 (Camp and L. B. B.).

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[1] Merriam, Birds of Conn., p. 8.

[2] *Bird-Lore*, xiv, 2, p. 114.

[3] *O. and O.*, xii, 10, p. 174.

[4] *Oölogist*, vi, 12, p. 231.

[5] *Bird-Lore*, xiv, 2, p. 114.

Eggs. 3-5; the last of May.

Nesting dates. Earliest record. May 12, 1894, five eggs (L. B. B.). Latest record. July 8, 1882, three eggs (L. B. B.).

The Brown Thrasher has been heard singing as late as Sept. 16 (1904) by L. B. B.

A female with the bill unusually long and slender and the maxilia extending .19 inch beyond the mandible, taken at New Haven, May 2, 1892 (C. F. Hedges, in coll. of L. B. B.).

## Family TROGLODYTIDÆ. Wrens.

**Thryothorus ludovicianus ludovicianus** (Latham). Carolina Wren.

A rare resident of the southern border, having apparently appeared, and certainly greatly increased, during the last few years.

Connecticut records. Merriam[1] gave no records, but said, "it doubtless occurs as a rare summer resident from the South in the Connecticut Valley and along our southern border". Nov. 15, 1878, Saybrook, one taken (J. N. C.)[2]; March 2, 1883, Portland, male shot (C. H. N.)[3]; 1884, Portland, one reported seen by Chas. Lincoln; March 18, 1886, East Hartford, male taken (W. E. T.)[4]; fall, 1891, Stamford, two taken (reported by Hoyt); April 8, 1892, Bridgeport, male taken (Eames)[5]; Oct. 23, 1894, Stamford, one taken (Hoyt, in coll. of L. B. B.); Nov. 30, 1894, Stamford, male (Schaler); April 20, 1895, two seen, June 13, 1895, same two and two young seen, near Bridgeport (Eames and Taylor)[6]; Dec. 17, 1897, Lyme, one seen (Brockway)[7]; April 7, 1900, Norwalk, pair seen (Smith)[8]; July 15, 1901, Chester, nest with five eggs (Watrous)[8]; winter, 1901-2, Norwalk, pair wintered (Smith)[9], May 2, 1902, Norwalk, nest (Smith)[1], Sept. 11, 1902, New Haven, young male taken (L. B. B.); Oct. 31, 1902, Guilford, young female taken, another seen, and still another Nov. 4, 1903 (L. B. B.); 1903, Norwalk, tow pairs nested (Smith)[1]; Nov. 4, 1903, Leete's Island, one seen (L. B. B.).

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[1] Merriam, Birds of Conn., p. 11.

[2] *Bull. Nuttall Ornith. Club,* iv, 1, p. 61.

[3] *Bull. Nuttall Ornith. Club,* viii, 2, p. 120.

[4] *Auk,* iii, 4, p. 489.

[5] *Auk,* x, 1, p. 89.

[6] *Auk,* xiii, 1, p. 84.

[7] *Auk,* xv, 2, p. 192.

[8] *Auk,* xix, 1, p. 91.

[9] *Bird-Lore,* v, 5, pp. 163-4

After 1903 records of this species in Connecticut ceased, and it is probable that nearly all of those Wrens perished in the cold winters of 1903-4 and 1904-5. In the winter of 1908-9 the Carolina Wren again appeared in numbers: New Haven, Dec. 25, 1908 — March 6, 1909, two seen on a dozen dates (A. W. H., C. H. P., D. B. P.), May 26, 1909, one (L. B. B.); Bethel, March 17, 1909, one (R. C. Judd); Bridgeport, May 9, June 1, 1909 (H. W. B.); Portland, Feb. 22, 23, June 11, 12, 18, 1909 (J. H. S.); Hartford, May 16, 1909, one seen (Smith, Powers, and Gabriel). Since then we have no records until Nov. 16-23, 1911, when a male was seen and heard singing at East Hartford by W. E. T. The bird remained and was in full song Aug. 20, 1912. Westbrook, Aug. 4, 1912, nest with two young (Mrs. L. W. Gregg). Probably this Wren still occurs near Stamford, where it was apparently firmly established as early as 1895.

**Troglodytes aëdon aëdon** Vieillot. House Wren.

A tolerably common summer resident of orchards from May to September; not abundant anywhere, and apparently decreasing in numbers.

Earliest record. New Haven, April 26, 1909, April 24, 1906 (A. A. S.); Portland, April 19, 1896.

Latest record. New Haven, Oct. 14, 1907, Oct. 16, 1906 (E. S. W.); Portland, Sept. 26, 1893; East Hartford, Oct. 16, 1887 (W. E. T.).

Nest. In a hollow in a tree, commonly an apple, in a post or a building, occasionally in the deserted nest of a Baltimore Oriole.[2] Height from ground, 6 to 18 feet.

Eggs 3-8, the last of May.

Nesting dates. Earliest record. May 23, 1884, three eggs (L. B. B.). Latest record. Aug. 12, 1900, five eggs (W. R. Nichols). A set of eight eggs was collected in Westville, New Haven, May 30, 1894 (H. W. F.).

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[1] *Bird-Lore*, v, 5, pp. 163-4.

[2] *Bird-Lore*, i, 5, p. 166. *Oölogist*, xiv, 6, p. 58.

The spread of the English Sparrows into the farming districts has probably had much to do with the decrease of this species, as they preëmpt all the suitable breeding hollows before the House Wrens arrive. In New Haven, where this Wren formerly bred commonly, even in the center of the city, its song is now seldom heard.

The House Wren has been heard singing as late as Sept. 16 (1904) by L. B. B.

**Nannus hiemalis hiemalis** (Vieillot). Winter Wren.

A tolerably common fall migrant in October, a much rarer winter resident and spring migrant; very rarely breeds in this state.

Fall migration. Earliest record. New Haven, Sept. 18, 1903; Portland, Sept. 23, 1893. Latest record. New Haven, Nov. 4, 1903; Portland, Nov. 27, 1889.

Winter records. Dec. 1, 1879, New Haven (Goodrich, in coll. of L. B. B.); Jan. 14, 1901, Jan. 15, 1902, March 7, 1903, Jan. 9, 1905, Guilford (L. B. B.); Feb. 1, 1877, Feb. 4, 1885, March 12, 1889, Feb. 22, 1890, Feb. 23, 1891, Feb. 22, 1899, Dec. 9, 1901, Dec. 21, 1908, Portland (J. H. S.).

Spring records. New Haven, May 15, 1889 (L. B. W.), April 10, 1889, May 3, 1904 (L. B. B.), March 29, April 26, 1907 (A. A. S. and C. H. P.); Bridgeport, May 3, 1892 (Eames).

Summer record. Sage's Ravine, Salisbury, July 5, 6, 1906, two pairs found (H. K. J.).[1]

One noticed singing as late as Nov. 4 (1903) by L. B. B.

**Cistothorus stellaris** (Naumann). Short-billed Marsh Wren.

A rare summer resident from June to September; tolerably common in parts of Litchfield County.

Earliest record. New Haven, May 22, 1890 (L. B. W.); Portland, May 15, 1888.

Latest record. New Haven, Oct. 13, 1906 (H. H. Townsend); Portland, Oct. 14, 1892.

Distribution. Litchfield, reported fairly common by E. S. W., and eggs found June 8, 1891, and June 27, 1907, and two birds taken by A. H. V., Sept. 15, 1894; Warren, June 9, 12, 1900, taken by L. B. B.; Bethel, reported regularly by G. L. Hamlin, eggs taken July 10, 1890, by H. C. Judd; Danbury, one pair reported regularly by G. L. Hamlin; New Haven, May 22, 1890 (L. B. W.), July 19, 1893 (Hedges and H. W. F.), Sept. 25, 1895 (H. W. F.), Oct. 13, 1906 (Townsend); Portland, fairly regular during the last week of September and first of October from 1890 to 1899 (Sept. 9, 1893, Oct. 14, 1892), also May 15, 1888, May 23, 1904, and May 16, 1910.

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[1] Job, The Sport of Bird Study, p. 310.

Nest. In grass of a shallow fresh-water marsh, from 1 to 2 feet from the ground.

Eggs. 5-8; the middle of June.

Nesting dates. Earliest record. June 8, 1891, seven eggs (L. B. W. and E. S. W.). Latest record. July 10, 1890, eggs (H. C. Judd).

**Telmatodytes palustris palustris** (Wilson). Long-billed Marsh Wren.

An abundant summer resident of the salt and brackish marshes from May to September.

Earliest record. New Haven, May 5, 1896; Portland, May 5, 1906, 1908.

Latest record. New Haven, Nov. 8, 1904; Portland, Oct. 26, 1887.

Winter records. Nov. 26, 1905, Feb. 24, 1906, March 6, 1906, Quinnipiac Marshes, North Haven (E. S. W.).

Nest. In grass of a marsh, cat-tails, sweet flag, or small bushes, from 1 to 6 feet from the ground, usually 1 to 3 feet.

Eggs. 2-6; the middle of June.

Nesting dates. Earliest record. June 1, 1905, five eggs (J. H. S.). Latest record. Aug. 24, 1903, two young (L. B. B.).

Unusual eggs. Set of four white eggs, June 24, 1893, Quinnipiac Marshes, North Haven (L. B. B.); set of five, same spot, less than 10 yards away, July 11, 1893; four more, in a nest about 8 feet from the first, July 28, 1893; Portland, June 8, 1905, set of six (J. H. S.).

This species has been heard singing as late as Sept. 18 (1895) and Sept. 26 (1904) by L. B. B.

## Family CERTHIIDÆ. Creepers.

**Certhia familiaris americana** Bonaparte. Brown Creeper.

A tolerably common winter resident from October to April; most common in October, but wintering regularly in small numbers.

Earliest record. New Haven, Sept. 22, 1903, 1904; Portland, Oct. 2, 1893; Litchfield, Sept. 19, 1906 (E. S. W.).

Latest record. New Haven, May 7, 1888; Portland, April 27, 1907; Danbury, April 28, 1907 (J. C. A. M.); East Hartford, May 7, 1892 (W. E. T.).

## Family SITTIDÆ. Nuthatches.

**Sitta carolinensis carolinensis** Latham. White-breasted Nuthatch.

A tolerably common resident, but less common than formerly in southern Connecticut.

Nest. In a hole, at least partially excavated by the birds themselves, in the trunk of a large tree in the woods at from 25 to 30 feet from the ground.

Eggs. 5-9; early in May.

Nesting dates. Earliest record. April 21, 1890, five eggs (J. H. S.). Latest record. May 30, 1877, six eggs (J. H. S.).

A set of eight eggs taken, May 13, 1902 (Hill); a set of nine eggs taken in Jewett City, May 19, 1884 (C. E. Prior).[1]

**Sitta canadensis** Linnæus. Red-breasted Nuthatch.

A common fall and rare spring migrant, and an irregular winter resident; most abundant in October.

Spring migration. Earliest record. New Haven, March 24, 1902; Portland, March 14, 1893, 1900. Latest record. New Haven, April 1, 1896, April 27, 1888 (L. B. W.); Portland, May 10, 1893.

Fall migration. Earliest record. New Haven, Aug. 27, 1903; Portland, Sept. 4, 1908. Latest record. New Haven, Nov. 4, 1903, Nov. 28, 1906 (A. A. S.); Portland, Oct. 18, 1888.

Winter records. New Haven, Feb. 22, 1894, Feb. 10, Dec. 10, 1896, Jan. 24, Feb. 6, 16, 21, 1900, Jan. 15, Dec. 30, 1902,

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[1] *O. and O.*, ix, 8, p. 100.

(L. B. B.), Jan. 25, 1907 (E. S. W.); Portland, Dec. 9, 30, 1895, Jan. 23 — Feb. 22, 1896, Dec. 6-18, 1899, Feb. 12, 1900, Jan. 15, 1902 (J. H. S.).

Breeding records. June 1, 1876, Winchester, nest with eggs found, the female being shot (in coll. of Williams);[1] June 27, 1896, Norfolk, male, female, and young taken by W. E. T. (in coll. of J. H. S.)

## Family PARIDÆ. Titmice.

**Bæolophus bicolor** (Linnæus). Tufted Titmouse.

A very rare visitor from the south.

The only Connecticut records are those noted by Merriam:[2] Linsley recorded it at New Haven; Feb. 27, 1872, one shot, Jan., 1874, one seen, Lyme (J. G. Ely); taken near Hartford by Dr. D. Crary.

**Penthestes atricapillus atricapillus** (Linnæus). Chickadee.

A common resident; keeping in family flocks except in the breeding seasons, and venturing into the cities in the fall and winter.

Nest. In a hole excavated by the birds in a dead stump or limb at from 10 inches to 20 feet from the ground. The entrance is often from the top of the stump, and the nest cavity sometimes extends below the ground level.

Eggs. 3-10; the middle of May.

Nesting dates. Earliest record. May 11, 1891, seven eggs (J. N. C.). Latest record. July 2, 1893, four eggs (A. H. V. and L. B. B.).

Unusual sets. Set of eight and another of nine reported at Wallingford in 1884 (J. R. M.);[3] set of eight taken at Ivoryton, May 28, 1895 (G. D. French, in coll. of L. B. B.); set of ten found May 30, 1904, and set of eight found May 18, 1907, at Portland (J. H. S.).

**Penthestes hudsonicus hudsonicus** (J. R. Forster). Hudsonian Chickadee.

The only Connecticut record for this species is reported in the *Bulletin of the Nuttall Ornith. Club* for July, 1876, and is quoted by Merriam:[1] "On Nov. 13, 1875, Mr. Robert Morris, while shooting in a wooded ravine a few miles from town (New Haven), killed a female Hudsonian Titmouse (*Parus Hudsonicus*). The specimen is now in the collection of Mr. Thomas Osborne of this city."

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[1] Job, The Sport of Bird Study, p. 311.

[2] Merriam, Birds of Conn., p. 9.

[3] *Young Oölogist*, i, 5, p. 70.

### Family SYLVIIDÆ. Warblers, Kinglets, Gnatcatchers.

### Subfamily Regulinæ. Kinglets.

**Regulus satrapa satrapa** Lichtenstein. Golden-crowned Kinglet.

An abundant fall and common spring migrant, and tolerably common winter resident; the majority passing through the state in October and November and again in March and April.

Spring migration. Earliest record. New Haven, March 1, 1898; Portland, March 2, 1898. Latest record. New Haven, April 28, 1906, May 11, 1906 (A. A. S.); Portland, April 25, 1888.

Fall migration. Earliest record. New Haven, Sept. 24, 1903; Portland, Oct. 8, 1890; Litchfield, Sept. 21, 1896 (L. B. W.). Latest record. New Haven, Nov. 22, 1904; Portland, Nov. 28, 1881.

Winter records. It has been observed in small numbers near New Haven during most winters by L. B. B., and in Portland during the winters of 1874-5, 1877-8, 1889-90, 1892-3, 1899-1900, 1902-3, 1910-11, by J. H. S.

**Regulus calendula calendula** (Linnæus). Ruby-crowned Kinglet.

A common fall and tolerably common spring migrant in October and April; mingling with the Golden-crowned Kinglet.

Spring migration. Earliest record. New Haven, April 7, 1888; Portland, April 8, 1889. Latest record. New Haven, April 27, 1907, May 14, 1907 (A. A. S.); Portland, May 6, 1891; Litchfield, May 10, 1905 (E. S. W.).

Fall migration. Earliest record. New Haven, Sept. 22, 1904; Portland, Sept. 26, 1893. Latest record. New Haven, Oct. 28, 1904, Nov. 4, 1907 (A. A. S.), Nov. 24 (Merriam);[2] Portland,

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[1] Merriam, Birds of Conn., p. 10.

[2] Merriam, Birds of Conn., p. 8.

Oct. 26, 1892; Guilford, Nov. 22, 1894, one with slightly injured leg taken (L. B. B.).

A young male with the crown patch orange-buff and the entire plumage more gray even than adults in spring was collected in New Haven, Oct. 28, 1904, by L. B. B.

### Subfamily Polioptilinæ. Gnatcatchers.

**Polioptila cærulea cærulea** (Linnæus). Blue-gray Gnatcatcher.

Very rare summer visitant.

Connecticut records. Linsley recorded it from Stratford;[1] 1874 (male), 1876 (female), Wauregan, shot by C. M. Carpenter;[1] May 11, 1883, Portland, male shot (in possession of J. W. Lord);[2] Sept. 1, 1885, New Haven, young male taken (L. C. S.);[3] May 7, 1886, East Hartford, female killed (W. E. T.);[4] April 6, 1892, Stratford, one heard (Eames).[5]

## Family TURDIDÆ. Thrushes, Solitaires, Stonechats, Bluebirds, etc.

### Subfamily Turdinæ. Thrushes.

**Hylocichla mustelina** (Gmelin). Wood Thrush.

A common summer resident throughout the state from May till September; abundant along the southern border.

Earliest record. New Haven, April 26, 1900; Portland, April 28, 1902.

Latest record. New Haven, Oct. 3, 1895, 1903, Oct. 4, 1906 (E. S. W.); Portland, Sept. 18, 1893.

Nest. In a sapling or tree in the deep woods, 2-25 feet from the ground. Building, May 10-25.

Eggs. 3-5; the last of May or first week in June.

Nesting dates. Earliest record. May 16, 1900, four eggs (Hill). Latest record. July 22, 1904, three eggs (L. B. B.).

Spotted eggs have occasionally been taken by J. H. S.,[6] W. W. C.,[6] J. N. C.,[6] and W. R. Nichols.

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[1] Merriam, Birds of Conn., p. 8.

[2] *Bull. Nuttall Ornith. Club*, viii, 3, p. 179.

[3] *O. and O.*, xii, 9, p. 156.

[4] *Auk*, iii, 4, p. 487.

[5] *Auk*, x, 1, p. 89.

[6] Merriam, Birds of Conn., p. 6.

A young albino without a single dark feather was taken in Trumbull, July 10, 1889 (in Averill coll. of the Bpt. Sci. Soc.).

**Hylocichla fuscescens fuscescens** (Stephens). Wilson's Thrush. Veery.

A common summer resident of damp woodland throughout the state from May until July.

Earliest record. New Haven, May 1, 1896, April 30, 1888 (L. B. W.), 1906 (A. A. S.); Portland, April 27, 1907.

Latest record. New Haven, Sept. 22, 1903; Portland, Aug. 30, 1894.

Nest. On the ground underneath a bush or among dead leaves in the woods, in a tussock of grass in a swamp, very rarely as much as a foot above the ground in a bush. Building, May 15-30.

Eggs. 4-5; the last of May.

Nesting dates. Earliest record. May 20, 1900, three eggs (J. C. A. M.). Latest record. June 13, 1905, Litchfield (E. S. W.).

Spotted eggs were found in Litchfield, May 30, 1903 (L. B. W. and E. S. W.).

**Hylocichla fuscescens salicicola** Ridgway. Willow Thrush.

A visitor from the West during migrations.

Connecticut records. May 5, 1894, Woodbridge; Sept. 23, 1895, New Haven; May 16, 1900, May 14, 1904, East Haven; each time an adult male taken by L. B. B.

**Hylocichla aliciæ aliciæ** (Baird). Gray-cheeked Thrush.

A common spring and fall migrant in May and September.

Spring migration. Earliest record. New Haven, May 9, 1900; Portland, May 11, 1893; Litchfield, May 7, 1905 (E. S. W.). Latest record. New Haven, May 27, 1896, May 29, 1907 (A. A. S.); Portland, May 27, 1885; Seymour, May 29, 1888 (Eames); Bridgeport, May 29, 1889 (Eames).

Fall migration. Earliest record. New Haven, Sept. 5, 1906; Portland, Sept. 14, 1895. Latest record. New Haven, Oct. 11, 1906; Portland, Sept. 26, 1893; East Hartford, Oct. 5, 1887 (W. E. T.).

**Hylocichla aliciæ bicknelli** Ridgway. Bicknell's Thrush.

A rather rare spring and fall migrant in May and late September; associating with the Gray-cheeked Thrush.

Spring migration. New Haven, May 15 (1907, 1908)—May 22 (1902).

Fall migration. New Haven, Sept. 17 (1903)—Oct. 24 (1895). H. W. F.

Spring records. May 16, 1900, May 22, 1902, May 20, 1906, May 15, 1907, 1908, New Haven (L. B. B.).

Fall records. Sept. 23, 1893, Stamford, male (Porter); Oct. 3, 1895, New Haven, male (A. H. V., in coll. of L. B. B.); Oct. 24, 1895, New Haven, male (H. W. F.); Sept. 17, 30, Oct. 3, 1903, Sept. 21, 1904, Oct. 1, 1904, Sept 27, 1905, Oct. 9, 1906, Oct. 5, 1907, Oct. 9, 1911, New Haven (L. B. B.); Oct. 11, 1906, New Haven (E. S. W.); Oct. 3, 1908, Easton ( H. W. B.).

**Hylocichla ustulata swainsoni** (Tschudi). Olive-backed Thrush.

A tolerably common spring and fall migrant in May and September.

Spring migration. Earliest record. New Haven, May 10, 1900, 1904; Portland, May 7, 1894. Latest record. New Haven, May 25, 1908, May 29, 1907 (A. A. S.); Portland, May 29, 1893.

Fall migration. Earliest record. New Haven, Sept. 7, 1903, Sept. 4, 1874 (Hall);[1] Portland, Sept. 28, 1876. Latest record. New Haven, Oct. 4, 1895, 1901, Oct. 12, 1887 (H. W. F.), Oct. 13 (Merriam);[1] Portland, Oct. 5, 1886; Litchfield, Oct. 19, 1886 (L. B. W.); Guilford, Nov. 10, 1906 (E. S. W.).

**Hylocichla guttata pallasi** (Cabanis). Hermit Thrush.

A common spring and fall migrant in April and October, breeding regularly in the northwestern part of the state, and wintering rarely along the coast.

Spring migration. Earliest record. New Haven, March 16, 1907; Portland, April 6, 1875, 1888. Latest record. May 17, 1907, May 18, 1893 (A. H. V.); Portland, May 8, 1888.

Fall migration. Earliest record. New Haven, Sept. 29, 1883; Portland, Oct. 2, 1893, 1899. Latest record. New Haven, Dec.

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[1] Merriam, Birds of Conn., p. 7.

1, 1883; Portland, Oct. 27, 1884, 1885; East Hartford, Nov. 8, 1890 (W. E. T.).

Winter records. Dec. 14, 22, 1877, Portland (J. H. S.); March 1, 1878, New Haven (Hotchkiss); Jan. 6, 1882, Guilford (L. B. B.); Jan., 1883, Saybrook (J. N. C.);[1] Dec. 26, 1892, New Haven (H. W. F.); Jan. 22, 1896, East Haven (L. B. B.); Jan. 8, 1901, Portland (J. H. S.); Dec. 18, 1903, Guilford (L. B. B.); Jan. 1, 1904, Bristol (Smith and Bruen); Jan. 19, 1907, New Haven (A. A. S.); Feb. 13, 1911, Portland (J. H. S.).

Summer records. June 19, 1887, Hartford County, nest with three eggs found ("An Observer");[2] July 2, 1891, Litchfield, speckled young found, probably one of a brood raised near by (L. B. W.);[3] June 20, 23, 1893, two nests containing three eggs each taken at Norfolk (J. H. S.);[4] June 18, 1904, Salisbury, several heard and one taken (J. H. S. and L. B. B.); May 27, 1905, Litchfield, breeding female taken (E. S. W.); July, 1906, Salisbury (H. K. J.); June 23, 1907, Litchfield, male in song (E. S. W.).

**Planesticus migratorius migratorius** (Linnæus). Robin.

An abundant summer and an irregular winter resident; the majority arriving in March and leaving in October.

Earliest record.[5] New Haven, March 7, 1903, 1910, March 3, 1902 (A. A. S.); Portland, March 3, 1884.

Latest record.[5] New Haven, Nov. 28, 1900, 1903; Portland, Nov. 27, 1881.

Winter records. This species has been recorded in January, February, or December, in New Haven, 1882, 1883, 1884, 1885, 1886, 1896, 1902, 1903, 1904, 1905 (L. B. B.); 1887 (L. B. W.); 1906 (E. S. W.); 1907, 1908, 1909, 1910 (D. B. P.); in Portland, 1863, 1880, 1882, 1885, 1886, 1890, 1891, 1892, 1893, 1896, 1897, 1899, 1900, 1905, 1906, 1907, 1910 (J. H. S.). A few probably winter regularly each year.

Nest. In almost every possible situation; the fork of a limb of a tree, on a stump close to the ground, on a fallen limb, a pile of brush, a tree-box, on the porch of a house or the rafter of a barn, on a ledge of rocks, on a fence rail — most frequently in a tree. Height from ground, 3-60 feet; rarely, on the ground. Building, April 15 to May 10.

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[1] *O. and O.*, viii, 10, p. 80.

[2] *Oölogist*, viii, 4, p. 92.

[3] *Auk*, ix, 2, p. 202.

[4] *Auk*, x, 4, p. 371.

[5] Migrants.

Eggs. 2-5, usually 3 or 4; early in May.

Nesting dates. Earliest record. April 21, 1883, two eggs (L. B. B.). Latest record. August 3, 1882, four young (L. B. B.).

Spotted eggs are occasionally found; e. g., 1884, Guilford, set of four, profusely but faintly spotted with Mars brown (Wildman); 1885, *ibid.*, four more heavily marked (Wildman); May 28, 1897, Woodbridge, set of three (H. W. F.).

Runt eggs have been noted: June 3, 1882, Guilford, two (L. B. B.); June 10, 1894, Branford, one (L. B. B.).

Peculiar nests. May 12, 1894, New Haven, nest made of thin strips of tissue paper, which depended from it in long streamers (A. H. V.); May 22, 1898, nest with four eggs on the ground on a railroad embankment (J. C. A. M.); May 15, 1903, Trumbull, twin nest on girder in a barn, one containing four eggs of Robin, the other five deserted eggs of Phœbe (Beers); May 7, 1907, Portland, nest in old Flicker's hole (J. H. S.).

Partial albinos are quite common, having been noted a number of times in New Haven by L. B. B., and in Portland by J. H. S.

The Robin has been heard singing as late as Oct. 29 (1895) by L. B. B.

**Sialia sialis sialis** (Linnæus). Bluebird.

An abundant summer and common winter resident; migrants arriving early in March and leaving in October and November.

Earliest record.[1] New Haven, March 6, 1894, March 4, 1901, 1906 (A. A. S.); Portland, March 2, 1900.

Latest record.[1] New Haven, Nov. 25, 1903, Nov. 26, 1906 (A. A. S.); Portland, Nov. 27, 1889.

Winter records. This species has been recorded in January, February, or December, in New Haven, 1882, 1883, 1884, 1886, 1888, 1889, 1896, 1898, 1900, 1901, 1902, 1903, 1904 (L. B. B.); 1887 (L. B. W.); 1906 (E. S. W.); 1907, 1908, 1909, 1910 (D. B. P.); in Portland, 1861, 1871, 1874, 1877, 1878, 1880, 1881,

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[1] Migrants.

1882, 1883, 1884, 1886, 1890, 1891, 1893, 1895, 1896, 1898, 1901, 1903, 1905, 1907, 1908, 1909, 1910, 1911 (J. H. S.).

Nest. In a box or natural hole in a tree, or in the deserted home of a woodpecker; usually in an orchard but occasionally in deep woods; 3½ to 20 feet from the ground.

Eggs. 3-7, usually 4 or 5; the last of April.

Nesting dates. Earliest record. April 12, 1898, seven eggs (Hill). Latest record. July 8, 1882, three eggs (L. B. B.).

White eggs have several times been found; e. g., May 30, 1876, Essex, four (H. W. F.); July 8, 1882, Guilford, three (L. B. B.); May 23, 1892, Stamford (Rowell); April 28, 1898, Newtown, four (Canfield).

Although the Bluebird was almost exterminated in the winter of 1895 by the long continued cold weather in the South, and was consequently very rare that summer and in 1896, yet it had regained its former abundance by 1898.

This species while wintering has been found inside of a stack of hay, Feb. 22, 1886 (L. B. B.), in an old Robin's nest, Feb. 11, 1882 (L. B. B.), March 31, 1906 (E. S. W. and L. B. B.), in a hollow post in mid-winter, about 1883 (Augur). It probably chooses such sheltered places in which to pass the nights.

This species has been heard singing as early as Feb. 28 (1883), and as late as Oct. 22 (1892), by L. B. B.

A male Bluebird of a brilliant cobalt-blue, like Florida specimens, was taken April 13, 1901, New Haven, by L. B. B.

# APPENDICES TO PART I.

## 1. CATALOGUE OF INTRODUCED SPECIES AND DOUBTFUL SPECIES.

**Chenalopex ægyptiaca** (Linnæus). Egyptian Goose.

Two were seen flying about the Connecticut river, at Portland, Oct. 20, 1895, and one was shot. Both were undoubtedly escaped tame birds; but they must have come from a distance, as none, so far as is known, were ever kept within twenty miles of Portland.

**Grus americana** (Linnæus). Whooping Crane.

**Grus mexicana** (Müller). Sandhill Crane.

Though these species are reported by many of the earlier writers on Natural History as more or less common in the surrounding states, there seems to be no definite record of the capture of either in Connecticut. Undoubtedly both occurred when the country was discovered, but there is little probability that either has been taken within the last hundred years.

**Erolia ferruginea** (Brünnich). Curlew Sandpiper.

There are but two records of this species in this state, both appearing in Merriam:[1] one shot near Saybrook "some time ago" (J. G. Ely, 1877), and one killed Oct. 3, 1859, East Hartford (reported by Dr. D. Crary of Hartford). Neither of these records can be considered absolutely trustworthy.

The record of Dr. Thompson, as reported by Merriam, was proven later by L. C. S. to be that of a Stilt Sandpiper.

**Coturnix coturnix** (Linnæus). European Quail. Migratory Quail.

Numbers of these birds were liberated in 1878, at Lakeville, by the Salisbury Bird and Fish Protective Company. They nested that year and also in 1879, but so far as we know none are now to be found.

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[1] Merriam, Birds of Connecticut, p. 106.

**Perdix perdix** (Linnæus). Gray Partridge.

During 1908 and 1909 about 3,000 birds of this species were imported from Europe by our Game Commission and released in different parts of Connecticut, and a large number in 1910.[1] As the majority brought to the United States came from Hungary, this bird has become commonly known as the Hungarian Partridge.

During 1909 a number were reported to have mated and raised young, but the majority seem to have disappeared. However, it is yet too soon to pronounce on the success of this attempt at introducing a foreign game-bird into our state.

**Tympanuchus cupido** (Linnæus). Heath Hen.

Abundant in dry, bushy places in southern New England in the days of the first white settlers, this species had been exterminated in Connecticut before the time of Linsley, but was reported to be still found in " shrubby barrens in Westford, Connecticut," by Nuttall,[2] who wrote some ten years earlier.

**Phasianus colchicus** (Linnæus). English Pheasant.

**Phasianus torquatus** Gmelin. Ring Pheasant.

Numbers of both these Pheasants were liberated by sportsmen at various places in Connecticut at different times between 1890 and 1900; but none of them seems to have succeeded in becoming acclimated, and almost all have disappeared.

The only records are: June 2, 1897, New Haven, one flushed (L. B. B.); Dec. 27, 1901, Gaylordsville, one female found, apparently killed by a hawk (E. H. A.); fall, 1904, some reported seen in the Connecticut valley (according to J. E. Bassett).

**Meleagris gallopavo silvestris** (Viellot). Wild Turkey.

With a history somewhat similar to that of the Heath Hen, and probably originally much more common over most of Connecticut, the Wild Turkey disappeared about the same date.

Linsley states: " The last wild turkey that I have known in Connecticut, was taken by a relative of mine, about thirty years since, on Totoket Mountain, in Northford. It was overtaken in a deep snow, and thereby outrun. It weighed, when dressed, twenty-one pounds."[1]

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[1] Oldys, Yearbook Dept. Agriculture for 1909, pp. 255-6.

[2] Manual of the Ornithology of the United States and of Canada — the Land Birds, 1832, p. 662.

**Sturnus vulgaris** Linnæus. Starling.

An increasingly common resident.

This species was introduced into New York City in 1890, whence it has spread from Central Park through the neighboring country. It is constantly increasing in numbers, and is now firmly established through various parts of the state, especially along the coast.

Its spread may be shown by the following records of its first occurrence: June 10, 1900, Norwalk (Ells),[2] also winter, 1900-1; Aug. 25, 1900, Stamford (Smith, reported by Hoyt); Dec. 3, 1900, North Haven (L. B. B.); Jan., 1901, reported from Noroton, Stamford, and Norwalk; Oct., 1901, New Haven (A. A. S.);[2] winter, 1902-3, New Haven, five or six wintered; winter, 1903-4, about forty wintered; fall, 1906, flock of about 1500 seen (A. A. S. ); Jan., 1904, Bridgeport (Eames); spring, 1906, Wethersfield (Morgan);[2] March, 1906, Danbury (J. C. A. M.); 1906, New London and Stonington (Buttrick); April, 1907, Bethel (Judd);[2] June, 1907, Middletown (Cady); 1908, Portland (J. H. S.).

Since these records, they have increased very rapidly and are breeding in large numbers. Mrs. Bonner writes from Stamford:[3] "They have appropriated not only all the holes in the old apple trees, including those stolen from the Bluebirds by the English Sparrows, but also the holes in all the big lawn trees, hitherto occupied by Flickers, etc." It is not yet numerous in the interior of the state.

Nest. In a hollow of some sort, or in a church steeple.

Eggs. 4-6; the last of April.

Nesting dates. Earliest record. May 5, 1904, six young (Perry); May 2, 1910, three eggs (J. H. S.). Latest record. July 11, 1904, two young (L. B. B.).

**Carduelis carduelis** (Linnæus). European Goldfinch.

G. E. Verrill of New Haven writes in the *Auk,* ix, 3, p. 301: "On May 9, 1892, I took a very full-plumaged male European

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[1] Catalogue of the Birds of Connecticut, *Am. Jour. Sci. and Arts,* xliv, 2, p. 264, 1843.

[2] *Bird-Lore,* ix, 5, pp. 207-9.

[3] *Bird-Lore,* ix, 4, p. 171.

Goldfinch in an orchard near here. The bird was in full song, and did not bear any evidence of having been in captivity, as it was not particularly tame; the plumage was perfect, even to the tips of the tail feathers, and the legs and feet were those of a wild bird. It seems to me probable that it was a straggler from some of the localities where they have been introduced and have become naturalized, as I have never seen any near here before."

This is the only published record of this species in this state.

This specimen is now in the Peabody Museum. It was probably a wanderer from a small colony in Central Park, New York City.

**Passer domesticus** (Linnæus). English Sparrow.

"Introduced into Boston by the city government in 1868",[1] by 1877 the English Sparrow was "an abundant resident in all the larger and most of the smaller towns throughout the state (Connecticut).[2]

An abundant resident of the cities, villages, and farms, having driven Martins and Bluebirds and Eave Swallows from their nesting sites, as well as routing out other species by its warlike habits.

Nest. Breeds in any hole it can find, in martin-boxes, in holes in trees, or in buildings. Wanting these, it will occupy a Cliff Swallow's or Eave Swallow's nest, or build rough nests behind window blinds, in ivy on buildings, or in trees. Occasionally it adopts the habit of woodpeckers, chipping out a hole for itself in a tree after it has been started by a woodpecker (e. g., March 21, 1910, L. B. B.).

Eggs. 4-6; early in April, and successively throughout the summer.

Nesting dates. Earliest record. March 28, 1898, five eggs (J. C. A. M.). Latest record. July 6, 1891, five eggs (J. C. A. M.).

A set of five white eggs was taken, May 22, 1889, New Haven, by C. F. Hedges, where another set had been found in the previous year.

Partial albinos are quite common, especially among young birds.

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[1] Baird, Brewer & Ridgway, Birds of North America, i, p. 526.

[2] Merriam, Birds of Connecticut, p. 40.

Courting antics have been noticed as early (or late) as Dec. 24, 1903 (L. B. B.).

New Haven, Dec. 10, 1900, male with lower mandible gone and upper grown to a remarkable length, taken (A. H. V., in coll. of L. B. B.).

**Guiraca cærulea cærulea** (Linnæus). Blue Grosbeak.

Connecticut records: May 9, 1902, Bethel, male seen in an orchard (Hamlin); summer, 1903, New Canaan, one seen (Mrs. Neidé, recorded by Hoyt).

**Vermivora lawrencei** (Herrick). Lawrence's Warbler.

**Vermivora leucobronchialis** (Brewster). Brewster's Warbler.

Although it seems now beyond question that the birds called by these names are not independent species, it has not yet been conclusively shown whether they are hybrids between *Vermivora pinus* and *V. chrysoptera,* or phases of plumage of these species. Brewster's Warbler completely intergrades with the Blue-winged, while males at least of Lawrence's show usually little variation in plumage. As a very large proportion of the specimens of these puzzling birds so far reported were taken in Connecticut, we have tried to give here a summary of these records with the addition of others. Brewster's Warbler is much the more common.

**Vermivora lawrencei.** Greenwich, July 12, 1893, female taken, with young in first plumage, by C. G. Voorhees.[1] Stamford, May 12, 1886, male taken, May 23, 1888, female taken, May 25, 1888, male taken (W. H. H., last two in coll. of L. H. P.); May 25, 1905, male taken (L. B. B.). Greenfield Hills, May 31, 1906, male seen (E. S. W.). Danbury, 1900 (?), male taken (J. C. A. M.). Bridgeport, May 16, 1889, male taken, spring of 1891, three seen, seven seen in one spring[2] (E. H. E.). New Haven, May 21, 1888, female taken, May 13, 1891, male taken (H. W. F., these in coll. of W. Brewster); May 17, 1892, male taken (H. W. F.); May 15, 1896, male taken, May 21, 1902, female, intermediate with *V. chrysoptera* mated with a male *V. pinus,* taken (A. H. V., all in coll. of L. B. B.); May 13, 21, 1898, two males taken (A. H. V.); May 20, 1896, male taken,

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[1] *Auk,* xi, 1, pp. 259-60.

[2] *Auk,* x, 1, p. 89.

May 11, 1900, male taken, intermediate with *V. chrysoptera,* May 10, 1904, male taken, May 31, 1905, male taken, May 24, 1906, male taken, May 20, 1909, male taken (these three within space of 300 yards), June 4, 1909, male taken with mate female *V. pinus,* and four eggs and two Cowbird's eggs, May 21, 1912, male taken (L. B. B.); May 29, 1906, male seen (J. Dwight, Jr., and L. B. B.). Portland, May 14, 1887, May 16, 1894, May 10, 1895, three males taken (S. R., all in coll. of J. H. S.).

**Vermivora leucobronchialis.** Wauregan (Plainfield), May 25, 1875, male taken (C. M. Carpenter).[1] Suffield, July 3, 1875, male taken (E. I. Shores).[2] Saybrook, May 30, 1879, male taken,[3] spring of 1880, one seen,[4] May 13, 1888, one seen, May 8, 1889, one taken,[5] frequently seen and taken and nest found (J. N. C.). Stamford, May 20, 1893, male taken (L. H. P.). Bridgeport, June 14, 1892, male seen mated with *V. pinus,* nest contained four eggs, two of which were Cowbird's (E. H. E.);[6] fifteen males seen between Bridgeport and Seymour, spring of 1889 (E. H. E.); Seymour, May 26, 29, male taken, June 1, 4, 10, two, June 19, July 7, 1888, seen (E. H. E.).[7] Milford, June 2, 1903, female taken with six eggs and one Cowbird's egg (J. C. A. M., female in coll. of L. B. B.). Deep River, May 18, 1880, female taken.[8] New Haven, May 19, 1885, male taken (H. W. F., in coll. of J. H. S.), May 15, 1888, one seen, May 16, 1892, male taken, May 17, 1892, two males taken, May 12, 1893, male taken (H. W. F.); May, 1894, male taken (W. C. Morgan); May 14, 1896, male taken, May 28, 1898, female taken, mated with *V. pinus,* and five eggs, May 19, 1902, male taken (A. H. V., all in coll. of L. B. B.); May (?), 1905, male taken (E. S. W.); May 8-31, 1893, 1894, 1896, 1898, 1900, 1902, 1904, 1905, 1906, and 1910, nineteen males taken, one mated with *V. pinus,* July 4, 1893, female taken with two young, slightly paler yellow than *V. pinus,* May 24, 1904, female taken, June 10, 1904, female taken with four young dead in the nest, Sept. 12, 1907, young male taken, May 24, 1912, female taken (L. B. B.). Portland, May 22, 1875, male taken (W. W. C.),[1] May 31, 1886, May 26, 1887, males taken, May 10, 1888, male taken and another seen, June 10, 1889, May 24, 1890, May 15, 1891, males taken, June 13, 1891, one seen, May 13, 17, 1892, two males taken, May 30, June 2-15, 1893, one seen, May 10, 12, 1894, three males taken, May 25, 30, June 11, 1894, four males seen, June 23, 1894, female taken mated with *V. chrysoptera,* and four eggs, May 13, 1895, male taken, May 23, 30, 1896, May 13, 15, 17, 1899, May 14, 1900, May 12, 1901, seen, May 7, 1902, male taken, May 30, 1903, May 18, 1907, seen, June 6, 1908, male taken (S. R. and J. H. S.); May 27, 1904, male taken (L. B. B.). Waterbury, May 9, 1909, one seen (N. B. Pillery).[2]

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[1] *Bull. Nuttall Orn. Club,* iii, 2, p. 99.

[2] *Bull. Nuttall Orn. Club,* iii, 4, pp. 199-200.

[3] *Bull. Nuttall Orn. Club,* iv, 3, p. 184.

[4] *Random Notes on Natural Hist.,* ii, 6, p. 43.

[5] *O. and O.,* xiv, 8, p 119.

[6] *Auk,* x, 1, pp. 89-90.

[7] *Auk,* v, 4, pp. 427-428.

[8] *Auk,* i, 1, p. 91.

Dr. Eames has found this bird mated with *V. pinus* alone, and has found nests and watched the young develop into same plumages as the juvenal of *V. pinus.*

**Turdus pilaris** (Linnæus). Fieldfare.

Accidental.

The only Connecticut record is that of a specimen taken near Stamford in April, 1878,[3] by Schaler, who states that its actions were those of a wild bird. This specimen is now in the collection of Hoyt, and from the condition of its plumage and feet had certainly not been recently in captivity.

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[1] *Bull. Nuttall Orn. Club,* iv, 3, p. 184.

[2] *Bird-Lore,* xii, 2, pp. 78-9.

[3] *O. and O.,* xiv, 3, p. 44. (The date here is incorrect.)

## 2. STATISTICAL SUMMARY.

### RESIDENTS.

Gavia immer[1]
Anas rubripes
Marila marila[1]
Marila affinis[1]
Harelda hyemalis[1]
Charitonetta albeola[1]
Oidemia deglandi[1]
Oidemia perspicillata[1]
Botaurus lentiginosus[2]
Rallus crepitans crepitans[2]
Philohela minor[2]
Gallinago delicata[3]
Oxyechus vociferus[3]
Colinus virginianus virginianus
Bonasa umbellus umbellus
Bonasa umbellus togata
Zenaidura macroura carolinensis[2]
Circus hudsonius
Accipiter velox
Accipiter cooperi
Astur atricapillus atricapillus[1]
Buteo borealis borealis
Buteo lineatus lineatus
Haliæetus leucocephalus leucocephalus
Falco peregrinus anatum[3]
Falco sparverius sparverius
Aluco pratincola[3]
Asio wilsonianus
Asio flammeus[3]
Strix varia varia
Cryptoglaux acadica acadica[1]
Otus asio asio
Bubo virginianus virginianus
Ceryle alcyon[2]
Dryobates villosus villosus
Dryobates pubescens medianus
Sphyrapicus varius varius[3]
Phlœotomus pileatus abieticola[3]
Melanerpes erythrocephalus[2]
Colaptes auratus luteus[2]
Sayornis phœbe[2]
Otocoris alpestris praticola
Cyanocitta cristata cristata
Corvus brachyrhynchos brachyrhynchos
Corvus ossifragus[2]
Molothrus ater ater[2]
Agelaius phœniceus phœniceus[2]
Sturnella magna magna
Quiscalus quiscula æneus[3]
Carpodacus purpureus purpureus[2]
Astragalinus tristis tristis
Poœcetes gramineus gramineus[2]
Passerculus sandwichensis savanna[2]
Passerherbulus caudacutus[2]
Passerherbulus maritimus maritimus[2]
Zonotrichia albicollis[3]
Spizella pusilla pusilla[2]
Junco hyemalis hyemalis[1]
Melospiza melodia melodia
Melospiza georgiana[2]
Pipilo erythrophthalmus erythrophthalmus[2]
Iridoprocne bicolor[2]
Bombycilla cedrorum
Lanius ludovicianus migrans[1]
Dumetella carolinensis[2]
Toxostoma rufum[2]
Thryothorus ludovicianus ludovicianus
Nannus hiemalis hiemalis[3]
Telmatodytes palustris palustris[2]
Sitta carolinensis carolinensis
Sitta canadensis[1]
Penthestes atricapillus atricapillus
Hylocichla guttata pallasi[3]
Planesticus migratorius migratorius
Sialia sialis sialis

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[1] Rare or accidental in summer.
[2] Rare or accidental in winter.
[3] Rare or accidental both in summer and in winter.

Phasianus colchicus
Phasianus torquatus
Perdix perdix
Sturnus vulgaris
Passer domesticus

## SUMMER RESIDENTS.[1]

Podilymbus podiceps
Sterna hirundo
Sterna dougalli
Aix sponsa
Ixobrychus exilis
Ardea herodias herodias
Butorides virescens virescens
Nycticorax nycticorax nævius
Rallus elegans
Rallus virginianus
Porzana carolina
Creciscus jamaicensis
Bartramia longicauda
Actitis macularia
Ectopistes migratorius[2]
Buteo platypterus
Pandion haliaëtus carolinensis
Coccyzus americanus americanus
Coccyzus erythrophthalmus
Antrostomus vociferus vociferus
Chordeiles virginianus virginianus
Chætura pelagica
Archilochus colubris
Tyrannus tyrannus
Myiarchus crinitus
Nuttallornis borealis
Myiochanes virens
Empidonax virescens
Empidonax trailli alnorum
Empidonax minimus
Dolichonyx oryzivorus
Icterus spurius
Icterus galbula
Quiscalus quiscula quiscula
Ammodramus savannarum australis
Passerherbulus henslowi henslowi
Spizella passerina passerina
Zamelodia ludoviciana
Passerina cyanea
Spiza americana[2]
Piranga erythromelas
Progne subis subis
Petrochelidon lunifrons lunifrons
Hirundo erythrogastra
Riparia riparia
Stelgidopteryx serripennis
Vireosylva olivacea
Vireosylva gilva gilva
Lanivireo flavifrons
Lanivireo solitarius solitarius
Vireo griseus griseus
Mniotilta varia
Helmitheros vermivorus
Vermivora pinus
Vermivora chrysoptera
Vermivora rubricapilla rubricapilla
Compsothlypis americana usneæ
Dendroica æstiva æstiva
Dendroica cærulescens cærulescens
Dendroica magnolia
Dendroica pensylvanica
Dendroica fusca
Dendroica virens
Dendroica vigorsi
Dendroica discolor
Seiurus aurocapillus
Seiurus motacilla
Oporornis formosus
Geothlypis trichas trichas
Icteria virens virens
Wilsonia citrina
Wilsonia canadensis
Setophaga ruticilla

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[1] Besides those included in list of residents.

[2] Extinct in Connecticut.

Mimus polyglottos polyglottos
Troglodytes aëdon aëdon
Cistothorus stellaris
Hylocichla mustelina
Hylocichla fuscescens fuscescens

## WINTER RESIDENTS.[1]

Colymbus holbœlli
Colymbus auritus
Gavia stellata
Larus marinus
Larus argentatus
Mergus americanus
Mergus serrator
Anas platyrhynchos
Mareca americana
Nettion carolinense
Marila americana
Clangula clangula americana
Branta canadensis canadensis
Branta bernicla glaucogastra
Arquatella maritima maritima
Totanus melanoleucus
Archibuteo lagopus sancti-johannis
Haliæetus leucocephalus alascanus
Falco columbarius columbarius
Nyctea nyctea
Otocoris alpestris alpestris
Otocoris alpestris hoyti
Pinicola enucleator leucura
Loxia curvirostra minor
Loxia leucoptera
Acanthis linaria linaria
Spinus pinus
Plectrophenax nivalis nivalis
Calcarius lapponicus lapponicus
Passerculus princeps
Spizella monticola monticola
Passerella iliaca iliaca
Lanius borealis
Dendroica coronata
Dendroica palmarum hypochrysea
Anthus rubescens
Certhia familiaris americana
Regulus satrapa satrapa

## PERIODICAL VISITORS.[2]

Podilymbus podiceps
Larus delawarensis
Larus philadelphia
Phalacrocorax carbo
Phalacrocorax auritus auritus
Lophodytes cucullatus
Anas platyrhynchos
Anas rubripes
Mareca americana
Nettion carolinense
Querquedula discors
Dafila acuta
Aix sponsa
Marila americana
Marila marila
Marila affinis
Oidemia americana
Oidemia deglandi
Oidemia perspicillata
Erismatura jamaicensis
Branta canadensis canadensis
Branta bernicla glaucogastra
Botaurus lentiginosus
Ixobrychus exilis
Ardea herodias herodias
Rallus virginianus
Porzana carolina
Coturnicops noveboracensis
Gallinula galeata
Fulica americana

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[1] Besides those included in list of residents.

[2] Species occurring chiefly in the spring or fall migration. A number of the names in this list are included also in the previous lists.

Philohela minor
Gallinago delicata
Macrorhamphus griseus griseus
Arquatella maritima maritima
Pisobia maculata
Pisobia fuscicollis
Pisobia minutilla
Pelidna alpina sakhalina
Ereunetes pusillus
Calidris leucophæa
Totanus melanoleucus
Totanus flavipes
Helodromas solitarius solitarius
Bartramia longicauda
Numenius hudsonicus
Squatarola squatarola
Charadrius dominicus dominicus
Oxyechus vociferus
Ægialitis semipalmata
Ægialitis meloda
Arenaria interpres morinella
Ectopistes migratorius[1]
Circus hudsonius
Accipiter velox
Accipiter cooperi
Buteo borealis borealis
Buteo platypterus
Haliæetus leucocephalus leucocephalus
Falco peregrinus anatum
Falco columbarius columbarius
Falco sparverius sparverius
Pandion haliaëtus carolinensis
Asio flammeus
Sphyrapicus varius varius
Melanerpes erythrocephalus
Colaptes auratus luteus
Chordeiles virginianus virginianus
Nuttallornis borealis
Empidonax flaviventris
Empidonax traillii alnorum
Euphagus carolinus
Quiscalus quiscula æneus
Carpodacus purpureus purpureus
Spinus pinus
Plectrophenax nivalis nivalis
Calcarius lapponicus lapponicus
Passerculus princeps
Passerculus sandwichensis savanna
Passerherbulus nelsoni nelsoni
Passerherbulus nelsoni subvirgatus
Zonotrichia leucophrys leucophrys
Zonotrichia albicollis
Junco hyemalis hyemalis
Melospiza lincolni lincolni
Melospiza georgiana
Passerella iliaca iliaca
Petrochelidon lunifrons lunifrons
Iridoprocne bicolor
Riparia riparia
Lanius ludovicianus migrans
Vireosylva philadelphica
Lanivireo solitarius solitarius
Mniotilta varia
Vermivora rubricapilla rubricapilla
Vermivora celata celata
Vermivora peregrina
Compsothlypis americana usneæ
Dendroica tigrina
Dendroica cærulescens cærulescens
Dendroica coronata
Dendroica magnolia
Dendroica castanea
Dendroica striata
Dendroica fusca
Dendroica virens
Dendroica vigorsi
Dendroica palmarum palmarum
Dendroica palmarum hypochrysea
Seiurus noveboracensis noveboracensis
Seiurus noveboracensis notabilis
Oporornis agilis
Oporornis philadelphia
Wilsonia pusilla pusilla
Wilsonia canadensis
Anthus rubescens
Nannus hiemalis hiemalis
Certhia familiaris americana
Sitta canadensis
Regulus satrapa satrapa

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[1] Probably extinct.

Regulus calendula calendula
Hylocichla aliciæ aliciæ
Hylocichla aliciæ bicknelli
Hylocichla ustulata swainsoni
Hylocichla guttata pallasi

## ACCIDENTAL VISITORS.

Cepphus grylle
Uria lomvia lomvia
Alca torda
Alle alle
Stercorarius parasiticus
Stercorarius longicaudus
Rissa tridactyla tridactyla
Larus leucopterus
Larus kumlieni
Larus atricilla
Sterna paradisæa
Sterna antillarum
Sterna fuscata
Hydrochelidon nigra surinamensis
Rynchops nigra
Fulmarus glacialis glacialis
Puffinus gravis
Oceanodroma leucorhoa
Oceanites oceanicus
Sula leucogastra
Sula bassana
Pelecanus occidentalis
Fregata aquila
Chaulelasmus streperus
Spatula clypeata
Marila valisineria
Marila collaris
Clangula islandica
Histrionicus histrionicus
Camptorhynchus labradorius[1]
Somateria dresseri
Somateria spectabilis
Chen hyperboreus nivalis
Branta canadensis hutchinsi
Olor columbianus
Guara alba
Plegadis autumnalis
Herodias egretta
Egretta candidissima candidissima
Florida cærulea
Crex crex
Ionornis martinicus
Phalaropus fulicarius
Lobipes lobatus
Steganopus tricolor
Recurvirostra americana
Macrorhamphus griseus scolopaceus
Micropalama himantopus
Tringa canutus
Pisobia bairdi
Ereunetes mauri
Limosa fedoa
Limosa hæmastica
Catoptrophorus semipalmatus semipalmatus
Catoptrophorus semipalmatus inornatus
Tryngites subruficollis
Numenius americanus
Numenius borealis[2]
Ochthodromus wilsonius
Hæmatopus palliatus
Cathartes aura septentrionalis
Catharista urubu
Elanoides forficatus
Aquila chrysaëtos
Falco rusticolus obsoletus
Scotiaptex nebulosa nebulosa
Cryptoglaux funerea richardsoni
Surnia ulula caparoch
Picoides arcticus
Centurus carolinus
Antrostomus carolinensis
Muscivora forficata
Corvus corax principalis
Xanthocephalus xanthocephalus
Agelaius phœniceus fortis
Hesperiphona vespertina vespertina
Acanthis hornemanni exilipes

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[1] Extinct.
[2] Possibly extinct.

Acanthis linaria rostrata
Cardinalis cardinalis cardinalis
Piranga ludoviciana
Piranga rubra rubra
Bombycilla garrula
Protonotaria citrea
Dendroica cerulea
Mimus polyglottos polyglottos
Bæolophus bicolor
Penthestes hudsonicus hudsonicus
Polioptila cærulea cærulea
Hylocichla fuscescens salicicola

## RECAPITULATION

| | | | |
|---|---|---|---|
| Residents, | 80 | Transient Visitors, | 124 |
| Summer Residents, | 78 | Accidental Visitors, | 89 |
| Winter Residents, | 38 | Total, | 334[1] |

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[1] Including 5 introduced species. In this total each name is counted only once.

## 3. LIST OF OBSERVERS REFERRED TO BY INITIALS OR BY SURNAMES.

| Initials | Name | Location |
|---|---|---|
| C. K. A. | C. K. Averill | Bridgeport |
| C. K. A., Jr. | C. K. Averill | Bridgeport |
| E. H. A. | E. H. Austin | Stratford and Gaylordsville |
| H. W. B. | H. W. Beers | Bridgeport |
| L. B. B. | Dr. L. B. Bishop | New Haven |
| J. N. C. | *J. N. Clark | Saybrook |
| W. I. C. | W. I. Comstock | Norwalk |
| W. W. C. | *W. W. Coe | Portland |
| E. H. E. | Dr. E. H. Eames | Bridgeport and Seymour |
| H. W. F. | H. W. Flint | Deep River and New Haven |
| A. J. G. | A. J. Granniss | East Haven |
| H. T. G. | H. T. Gates | Hartford |
| A. W. H. | A. W. Honeywill, Jr. | New Haven |
| C. C. H. | C. C. Hanmer | East Hartford |
| C. G. H. | C. G. Hart | East Berlin |
| C. R. H. | C. R. Hooker | New Haven |
| G. L. H. | G. L. Hamlin | Bridgeport |
| J. H. H. | J. H. Hill | New London |
| P. B. H. | P. B. Haines | New Haven |
| S. T. H. | *S. T. Holbrook | Norwich |
| W. H. H. | W. H. Hoyt | Stamford |
| H. K. J. | Rev. H. K. Job | Kent and New Haven |
| C. E. L. | *C. E. Lincoln | Gildersleeve |
| J. C. A. M. | J. C. A. Meeker | Bridgeport and Danbury |
| C. H. N. | *C. H. Neff | Portland |
| C. H. P. | C. H. Pangburn | New Haven |
| D. B. P. | D. B. Pangburn | New Haven |
| L. H. P. | L. H. Porter | Stamford |
| C. L. R. | C. L. Rawson | Norwich |
| S. R. | S. Robinson | Portland |
| A. A. S. | A. A. Saunders | New Haven |
| J. H. S. | J. H. Sage | Portland |
| L. C. S. | Dr. L. C. Sanford | New Haven |
| C. C. T. | Prof. C. C. Trowbridge | New Haven |
| W. E. T. | W. E. Treat | East Hartford |
| A. E. V. | Prof. A. E. Verrill | New Haven |
| A. H. V. | A. H. Verrill | New Haven |

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* Deceased.

| Initials | Name | Location |
|---|---|---|
| G. E. V. | G. E. Verrill | New Haven |
| C. W. W. | C. W. Webb | New Haven |
| E. S. W. | *E. S. Woodruff | New Haven and Litchfield |
| J. M. W. | C. L. Rawson<br>(Jennie May Whipple) | Norwich |
| L. B. W. | L. B. Woodruff | New Haven and Litchfield |
| W. W. | Dr. W. Wood | East Windsor Hill |

| Surname | Name | Location |
|---|---|---|
| Adam | Sarah W. Adam | Canaan |
| Andrews | A. R. Andrews | New Haven |
| Augur | C. R. Augur | Woodbridge |
| Austin | E. H. Austin | Stratford and Gaylordsville |
| Averill | C. K. Averill, Jr. | Bridgeport |
| Ayres | *Dr. W. O. Ayres | East Hartford |
| Bailey | A. S. Bailey | Cobalt |
| Baldwin | A. H. Baldwin | New Haven |
| Barratt | *Dr. J. Barratt | Middletown |
| Beers | H. W. Beers | Bridgeport |
| Bernard | G. H. Bernard | New Haven |
| Blackwood | W. Blackwood | New Haven |
| Bliss | W. P. Bliss | Middletown |
| Brewster | W. Brewster | Cambridge, Mass. |
| Brockway | A. W. Brockway | Hadlyme |
| Brooks | *Capt. O. N. Brooks | Guilford |
| Bruen | F. Bruen | Bristol |
| Buck | H. R. Buck | Wethersfield |
| Buttrick | P. L. Buttrick | New Haven |
| Cady | Prof. W. G. Cady | Middletown |
| Camp | R. D. Camp | New Haven and Stamford |
| Canfield | *J. H. Canfield | Bridgeport |
| Carpenter | C. M. Carpenter | Wauregan |
| Case | C. M. Case | Hartford |
| Case | *G. R. Case | Norwich |
| Clark | *J. N. Clark | Saybrook |
| Crary | *Dr. D. Crary | Hartford |
| Dayan | *A. J. Dayan | New Haven |
| Dickerman | G. Dickerman | Danbury |
| Dunbar | W. L. Dunbar | Bridgeport |
| Dutcher | J. S. Dutcher | Watertown |
| Eames | Dr. E. H. Eames | Bridgeport and Seymour |
| Flint | H. W. Flint | Deep River and New Haven |
| Folsom | *E. A. Folsom | New Haven |
| Gabriel | G. H. Gabriel | Hartford |
| Gath | J. Gath | Torrington |
| Goff | J. L. Goff | Portland |

| Surname | Name | Location |
|---|---|---|
| Goodrich | C. W. Goodrich | New Haven |
| Gould | *F. H. R. Gould | Portland |
| Grinnell | Dr. G. B. Grinnell | New Haven and Milford |
| Hall | *Dr. F. W. Hall | New Haven |
| Hamlin | G. H. Hamlin | Bridgeport |
| Hanson | W. Hanson | Torrington |
| Hedges | C. F. Hedges | New Haven |
| Herman | O. Herman | New Haven |
| Hill | J. H. Hill | New London |
| Holt | J. Holt | Lyme |
| Hooker | C. R. Hooker | New Haven |
| Hotchkiss | *Dr. W. H. Hotchkiss | New Haven |
| Howes | P. G. Howes | Stamford |
| Hoyt | W. H. Hoyt | Stamford |
| Humphrey | *H. C. Humphrey | Hartford |
| Hurlbut | H. M. Hurlbut | Portland |
| Hurlbut | *Seymour Hurlbut | Portland |
| Hutchins | J. Hutchins | Litchfield |
| Job | Rev. H. K. Job | Kent and New Haven |
| Judd | Rev. H. C. Judd | Bethel |
| Judd | R. S. Judd | Bethel |
| Kedzie | A. S. Kedzie | New Haven |
| King | L. E. King | Middletown |
| Lester | M. Lester | Suffield |
| Linsley | *Rev. J. H. Linsley | Stratford |
| Locke | J. Locke | New Haven |
| Lucas | *W. H. Lucas | Bridgeport |
| Ludington | F. J. Ludington | North Haven |
| Ludington | H. Ludington | North Haven |
| McCook | P. J. McCook | Niantic |
| Merriam | Dr. C. H. Merriam | New Haven |
| Miles | W. A. Miles | Twin Lakes |
| Minor | W. T. Minor | New Haven |
| Mitchell | E. Mitchell | New Haven |
| Morgan | W. C. Morgan | New Haven |
| Moses | *S. G. Moses | Hartford |
| Nichols | *W. R. Nichols | Branford |
| Norton | R. Norton | Guilford |
| Osborne | A. D. Osborne, 3d. | New Haven |
| Osborne | T. B. Osborne | New Haven |
| Pangburn | C. H. Pangburn | New Haven |
| Pangburn | D. B. Pangburn | New Haven |
| Parkinson | Dr. G. H. Parkinson | Middletown |
| Parsons | *L. J. Parsons | New Haven |
| Pease | C. H. Pease | Canaan |
| Perry | Dr. E. Perry, Jr. | Bridgeport |

| Surname | Name | Location |
|---|---|---|
| Porter | L. H. Porter | Stamford |
| Powers | A. G. Powers | Hartford |
| Prior | C. E. Prior | Jewett City |
| Rawson | C. L. Rawson | Norwich |
| Reynolds | Prof. H. M. Reynolds | New Haven |
| Robbins | W. A. Robbins | New Haven |
| Robertson | J. B. Robertson | New Haven |
| Rowell | Dr. C. Rowell | Stamford |
| St. John | Prof. E. P. St. John | Hartford |
| Sanford | H. Sanford | Litchfield |
| Schaler | J. Schaler | Stamford |
| Searles | E. Searles | New Haven |
| Sherman | F. Sherman | New Haven |
| Shores | Dr. E. I. Shores | Suffield |
| Smith | E. Smith | Bristol |
| Smith | G. V. Smith | New Haven |
| Smith | M. T. Smith | Hartford |
| Smith | Prof. S. I. Smith | New Haven |
| Smith | W. F. Smith | South Norwalk |
| Silliman | *Prof. B. Silliman | New Haven |
| Sperry | *K. Sperry | New Haven |
| Stetson | J. Y. Stetson | New Haven |
| Stetson | Dr. P. R. Stetson | New Haven |
| Strong | N. B. Strong | Portland |
| Sweetland | A. R. Sweetland | |
| Taylor | H. H. Taylor | Bridgeport |
| Thompson | Dr. E. L. R. Thompson | New Haven |
| Townsend | H. H. Townsend | New Haven |
| Trowbridge | Prof. C. C. Trowbridge | New Haven |
| Tryon | *E. S. Tryon | Portland |
| Uhl | J. Uhl | Montowese |
| Verrill | Prof. A. E. Verrill | New Haven |
| Voorhees | C. G. Voorhees | Greenwich |
| Watrous | C. H. Watrous | Chester |
| Webb | C. W. Webb | New Haven |
| Welch | L. S. Welch | Hartford |
| Werking | F. J. Werking | Taftsville |
| Whitney | H. Whitney | New Haven |
| Wildman | F. J. Wildman | Guilford |
| Williams | C. H. Williams | Winchester |
| Woolsey | Dr. G. Woolsey | New Haven |

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## PART II

# Economic Ornithology

BY

LOUIS BENNETT BISHOP

# Economic Ornithology.

Birds are of value to the State as (1) destroyers of noxious insects, their eggs and larvæ, and also of small mammals, especially when such injurious animals appear in excessive numbers; (2) destroyers of weed seed; (3) replanters of forests; (4) food; (5) sport; (6) scavengers; (7) guides to fishermen; (8) means of mental enjoyment.

As destroyers of insects that infest the garden, orchard, field, and forest, and consumers of enormous quantities of weed seed, birds have their greatest economic value; and their feeding habits have been studied by ornithologists connected with the Department of Agriculture of the National Government and by others in similar positions in various states. Brief extracts from the results of these investigations will be found in the following pages. Suffice it here to say that only one Owl, a few Hawks, Crows, some Blackbirds, the Starling, and the English Sparrow seem undeserving of protection. But that an abundance of birds is of great benefit on the farm the following extract from "Useful Birds and their Protection" by E. H. Forbush, State Ornithologist of Massachusetts, will show: and this valuable work can be cordially recommended to all those who wish to study this subject further than is possible for us in this Bulletin. "My first attempt at availing myself of the services of the birds in an orchard was made in 1894-95, and the result was given in a bulletin issued by the State Board of Agriculture. In the winter birds were attracted to the orchard, and frequented the trees during the entire winter of 1894-95. In the fall, winter, and spring they destroyed thousands of the imagoes and eggs of the fall and spring cankerworm moths, the eggs of the tent caterpillar, and probably also the pupæ and imagoes of the codling moth, besides scales, tineids, and other enemies of the trees. When spring came, efforts were made to attract the summer birds to the orchard. These attempts met with such signal success that, although most of the eggs and young birds were destroyed by cats, boys, crows, and other agencies, the remaining injurious insects were so completely disposed of by the birds that the trees bore luxuriant foliage during the entire summer, and produced a good crop of fruit. This occurred in a season when the tent caterpillar and the cankerworm were remarkably prevalent. The only other orchard in the neighborhood that produced any fruit whatever was that of the nearest neighbor. This had been partly protected by tarred bands and partly by the birds from my place. Elsewhere in the town most of the apple trees were defoliated, and very few produced any fruit that year. While the result secured in such an exceptional year seemed remarkable, the experience of succeeding years has demonstrated that it was not so. Year after year we have kept the trees free from insect injury, without spraying or otherwise protecting the foliage, merely by a little effort and expenditure to attract the birds and furnish them safe homes. While the protection of the tree itself is essential (i. e., its trunk, limbs, twigs, and bark), the protection of its foliage, which shades the fruit and so allows it to mature, is also imperative."

As regulators of occasional outbreaks of noxious animals birds have played a valuable part more than once in the past. In the invasions of locusts that occur occasionally in the West, birds of all sorts — hawks, owls, geese, ducks, grouse, pigeons, shore birds, woodpeckers, gulls, crows, blackbirds, herons, vireos, sparrows, swallows, warblers, thrushes, and even hummingbirds — swarm to the feast and devour these insects in incredible numbers. The same thing is true when the hordes of the army-worm appear. In the plagues of mice that sometimes infest parts of Europe, hawks and owls flock to the spot, and feed on little else until these animals are reduced to their normal numbers. If we wantonly destroy our hawks and owls, we lay ourselves open to such outbreaks, and have removed those whose pleasure it would be to protect us in such an emergency.

The value of certain species as a source of food, and from the standpoint of sportsmen, is too well understood to require discussion. Formerly, when Roseate Terns (*Sterna dougalli*) were abundant in the Sound, fishermen could frequently ascertain the presence of bluefish by watching the actions of these birds, as they caught the smaller fish driven to the surface by the large ones; and any one who has watched the Herring Gulls (*Larus argentatus*) swarming at the mouths of the sewers of cities, will realize their value as scavengers. How far birds help in replanting forests is questionable, but there is no doubt that Jays and Pigeons do assist somewhat by transporting acorns and the seeds of other trees.

To provide mental enjoyment may not seem at first sight a part of the function of the State, but there is a large and steadily increasing body of people, valuable citizens, who derive great enjoyment from listening to the songs and studying the habits of birds, who will go where birds are and keep away where birds are not. Surely it is more to the advantage of the state to protect birds and encourage these people to live with us than it is to allow our smaller birds to be shot for the morsel of meat their bodies may afford. From this standpoint alone, the protection of birds is certainly a good investment for the state.

Those also who are interested in birds from a scientific standpoint must not be forgotten, as from their ranks have come most of the men whose investigations of the feeding habits of birds are quoted in the following pages. As almost all ornithologists begin their study of birds by collecting skins and eggs in boyhood — the training of the eye and ear in youth being apparently essential for success in field ornithology,— no laws making permits unreasonably difficult to obtain should be passed. Since under normal conditions at least twice as many birds die each year as are living at the beginning of the year, legitimate collecting can have but little effect on their numbers; and this the killing of a few vagrant cats would offset many times over.

## GREBES, LOONS, and AUKS.

### *Colymbidæ*, *Gaviidæ*, and *Alcidæ*.

Of the five species of **Grebes** and **Loons** occurring more or less frequently in Connecticut, only two breed with us, and those but rarely. Their habits are entirely aquatic except in the breeding season, and even then the Grebes build floating nests of decaying vegetation in lakes or ponds. Their food habits are such that they are of little economic importance. The food of the Loons is almost entirely small fish, while the Grebes vary this diet with aquatic insects, tadpoles, lizards, grass, locusts, and grasshoppers.

The **Auks** are found only as stragglers in our waters, and the small fish and crustaceans they consume are of no value.

## JAEGERS and MAN-O'-WAR BIRDS.

### *Stercorariidæ* and *Fregatidæ*.

Wanderers on our shores, the **Jaegers** find the terns on which they largely depend for food so rare that they do not stay long with us. Their ordinary method of procuring food is to chase a tern or small gull until the latter drops the fish it has in its bill or disgorges what it has swallowed. This the robber seizes before it reaches the water; then searches for a fresh victim. When forced to forage for themselves, they live on fish, frogs, crawfish, and even grasshoppers.

The **Man-o'-War Bird** (*Fregata aquila*) has the habits of the Jaegers, but is only accidental in our state.

## GULLS and TERNS.

### *Laridæ*.

All is flesh that a **Gull** can find to eat as long as it is not vegetable. Their usual food with us is fish, but the manner the **Herring Gulls** (*Larus argentatus*) collect at the mouths of the sewers of cities shows that other matter is not objectionable. They are the scavengers of the waters, feeding on all animal matter they can find, whether alive or dead. "Other times other manners"; the head of a Ptarmigan was found in the throat of a **Glaucous Gull** (*Larus hyperboreus*) shot by the author in Alaska, and Mr. E. T. Judd took a Yellow Warbler from the stomach of a **Ring-billed Gull** (*Larus delawarensis*) in North Dakota. In that state and in many parts of the West flocks of **Franklin's Gulls** (*Larus franklini*) following the plow, and alighting on the freshly turned sod in search of worms and grubs, are a common sight. Grasshoppers and locusts are also a welcome addition to the food of many species; mollusks, mammals, young birds, and eggs are freely taken when occasion offers, as is the most putrid carrion. Thus acting as scavengers, the good they do greatly outweighs any harm their killing the few birds can be, and, with their beauty, should cause them to receive all possible protection.

Devoted almost exclusively to a diet of small fish, the few **Terns** (*Sterna hirundo*) that now breed on our shores, are objects of beauty to those who are fortunate enough to see them. Formerly, fishermen found their presence in numbers an indication that large fish had driven the smaller to the surface, and considered them useful accordingly. The **Least Tern** (*Sterna antillarum*) feeds largely on grasshoppers, spiders, and aquatic insects, while one who has watched the **Black Terns** (*Hydrochelidon nigra surinamensis*) skimming over the ponds of the West after the manner of swallows, can have little doubt as to the chief source of their food. Both these birds are unfortunately too rare with us to influence our insects.

The **Skimmers** (*Rhynchopidæ*), **Fulmars** and **Petrels** (*Procellariidæ*), **Gannets** (*Sulidæ*), **Cormorants** (*Phalacrocoracidæ*), and **Pelicans** (*Pelecanidæ*), may be omitted from our study of feeding habits, as, although all feed on fish, they are very rare in Connecticut.

## DUCKS, GEESE, and SWANS.

### *Anatidæ.*

These birds are chiefly important from their food value and as objects of sport, as few of them are with us when they can find locusts, beetles, or grasshoppers, on which they frequently feed in summer. Many of them eat fish, crustaceans, and shellfish, and others various grasses and water plants. Their food has no market value in our state, but in parts of the West they do great damage in the wheat fields.

## HERONS, EGRETS, and BITTERNS.

### *Ardeidæ.*

The chief value of these birds is their grace and beauty, and the charm they add to the landscape; their economic importance is not great either for help or harm. They feed on small fish, frogs, occasionally a mouse, tadpoles, worms, grasshoppers, dragon-flies, and various insects. It is conceivable that at a fish-hatchery a **Great Blue Heron** (*Ardea herodias*) might be out of place, but in the rest of the state its presence is a distinct gain.

## RAILS, GALLINULES, and COOTS.

### *Rallidæ.*

The **Rails** have their main value from an economic standpoint as ornaments to the dinner table; the diet of wild rice on which the **Sora** (*Porzana carolina*) feeds showing why its flesh stands so much higher in the opinion of epicures than that of the **Clapper** and **Virginia Rails** (*Rallus crepitans crepitans* and *virginianus*) which "feed chiefly upon grasshoppers, snails, slugs, crabs, and aquatic insects" (Weed and Dearborn, "Birds in their Relation to Man").

The **Coot** (*Fulica americana*), which is sometimes tolerably common in fall, feeds upon the same food as the last mentioned Rails, and its flesh is not highly praised.

## SHORE BIRDS.

### *Limicolæ.*

The **Phalaropes** (*Phalaropodidæ*), **Avocets** and **Stilts** (*Recurvirostridæ*), **Woodcocks**, **Snipes**, and **Sandpipers** (*Scolopacidæ*), **Plovers** (*Charadriidæ*), and **Turnstones** (*Aphrizidæ*) were supposed to have their chief economic value as being "good to eat," and in addition furnishing sport and outdoor exercise for sportsmen. But this is by no means true. They are all insect-eaters, and no doubt destroy large numbers during the months they are with us. The Woodcock and Snipe feed on worms, grasshoppers, and other insects. Of the **Wilson's Snipe** (*Gallinago delicata*)—"eight out of the eleven stomachs opened by Professor Aughey contained from 38 to 60 locusts each, besides other insects" (Weed and Dearborn, "Birds in their Relation to Man," p. 231). The smaller Sandpipers, feeding about the pools of the salt marshes, probably have some effect on the hordes of mosquitoes by devouring their larvæ. Of the usefulness of some species in the West — most of them, alas!

now too rare with us to be of economic importance — Professor Bruner writes: "The Snipes, Sandpipers, Plovers, Phalaropes, Curlews, etc., are great destroyers of insects. Moving, as many of them do, in great flocks, and spreading out over the meadows, pastures, and hillsides, as well as among the cultivated fields, they do a large amount of careful police service in arresting the culprits among insects. They even pry them out of burrows and crevices in the earth, where these creatures lurk during daytime only to come forth after nightfall to destroy vegetation. The large flocks of Eskimo Curlews that formerly passed through eastern Nebraska, did magnificent work during years when the Rocky Mountain locust was with us, as did also the equally large flocks of Golden Plovers. The Bartramian Sandpiper even now is a great factor each summer in checking the increasing locusts on our prairies." (Proceedings of the Nebraska Ornithologists' Union at its Second Annual Meeting.)

In "Our Vanishing Shore Birds," Mr. W. L. McAtee, of the Biological Survey, says: "Few groups of birds more thoroughly deserve protection from an economic standpoint. Shore Birds perform an important service by their inroads upon mosquitoes, some of which play so conspicuous a part in the dissemination of diseases. Thus, nine species are known to feed upon mosquitoes, and hundreds of larvæ or 'wigglers' were found in several stomachs. Fifty-three per cent of the food of twenty-eight Northern Phalaropes in one locality consisted of mosquito larvæ. The insects eaten include the salt-marsh mosquito."

"Cattle and other live stock also are seriously molested by mosquitoes as well as by another set of pests, the horseflies. Adults and larvæ of these flies have been found in the stomachs of the Dowitcher, the Pectoral Sandpiper, the Hudsonian Godwit, and the Killdeer. Two species of shore birds, the Killdeer and Upland Plover, still further befriend cattle by devouring the North American fever tick."

"Crane-fly larvæ are frequently seriously destructive locally in grass lands and wheat fields. Among their numerous bird enemies shore birds rank high."

Of grasshoppers shore birds are very fond, and twenty-four species are known to feed on them.

" Shore birds are fond of other insect pests of forage and grain crops, including the army-worm, which is known to be eaten by the Killdeer and Spotted Sandpiper; also cut-worms, among whose enemies are the Avocet, Woodcock, Pectoral and Baird Sandpipers, Upland Plover and Killdeer.

" The principal farm crops have many destructive beetle enemies also, and some of these are eagerly eaten by shore birds. Bill-bugs, which often do considerable damage to corn, seem to be the favorite food of some of the shore birds."

" The economic record of the shore birds deserves nothing but praise. These birds injure no crop, but on the contrary feed upon many of the worst enemies of agriculture. It is worth recalling that their diet includes such pests as the Rocky Mountain locust and other injurious grasshoppers, the army-worm, cutworms, cabbage worms, cotton worm, cotton cutworm, boll weevil, clover-leaf weevil, clover-root curculio, rice weevil, corn bill-bugs, wire-worms, corn-leaf beetles, cucumber beetles, white grubs, and such foes of stock as the Texas fever tick, horseflies, and mosquitoes. Their warfare on crayfishes must not be overlooked, nor must we forget the more personal debt of gratitude we owe them for preying upon mosquitoes. They are the most important bird enemies of these pests known to us.

" Shore birds have been hunted until only a remnant of their once vast numbers is left. Their limited powers of reproduction, coupled with the natural vicissitudes of the breeding period, make their increase slow, and peculiarly expose them to the danger of extermination. They should be protected, first, to save them from the danger of extermination, and, second, because of their economic importance. So great, indeed, is their economic value, that their retention on the game list and their destruction by sportsmen is a serious loss to agriculture."

## GROUSE, PARTRIDGES, and QUAILS.

### *Tetraonidæ* and *Odontophoridæ*.

Of the usefulness of the **Bob-white** or **Quail** (*Colinus virginianus virginianus*) from the sportsman's standpoint it is unnecessary to speak, but that its importance to agriculture is even greater Dr. Sylvester D. Judd has abundantly shown in the Year Book of the Department of Agriculture for 1903 ("The Economic

Value of the Bob-white"). Dr. Judd finds that "the Bob-white is probably the most useful abundant species on the farm. It is one of the most nearly omnivorous birds, consuming large quantities of weed seeds, and destroying many of the worst insect pests with which the farmer has to contend. It does not injure grain, fruit, or any other crop.

"In the investigation 801 stomachs were examined, collected in every month of the year, though mostly during the hunting season, and obtained from twenty-one different states. . . . . As indicated by this material, the Bob-white is notable for the great variety of its food. It lives mainly on seeds, fruits, leaves, buds, insects, and spiders, though myriapods, crustaceans, mollusks, and even batrachians have been found in its stomach. The character of the diet varies with the season. The greatest proportion of animal matter is taken in late spring and early summer. The food for the year, as a whole, estimated from the analysis of the contents of stomachs and calculated by volume, is divided thus: animal matter, 14.93 per cent; vegetable matter, 85.07 per cent. The elements of the animal food are distributed as follows: beetles, 6.38 per cent of the total food; grasshoppers, 2.56 per cent; bugs, 2.83 per cent; caterpillars, 0.87 per cent; miscellaneous insects, 0.48 per cent; the other invertebrates, largely spiders, 1.81 per cent. The vegetable food consists of grain, 23.64 per cent of the total food; various seeds, chiefly those of weeds, 50.78 per cent; fruit, 8.53 per cent; miscellaneous vegetable matter, 2.12 per cent.

"The Bob-white is pre-eminently a seed eater. Of its food for the year, as a whole, seeds form 50.78 per cent, and include those of many different plants.

"The bulk of this seed diet consists of the seeds of weeds. Fully sixty different weeds are represented in the food, and constitute more than a third of the food for the year as a whole. Some idea of the value of the bird as a weed destroyer may be gained from the number of seeds taken at a meal. Thirty buttonweed seeds, 200 to 300 smartweed seeds, often 500 seeds of sheep sorrel, and 700 of three-seeded mercury have been taken at one feeding. Crops and stomachs are frequently crammed with nothing but ragweed. One bird, taken at Marshall Hall, Md., November 6, 1902, had eaten a thousand ragweed akenes; another, killed the previous November in the same place, had eaten an equal number of the seeds of crabgrass, a troublesome weed in truck land. Birds have been shot in Mecklenburg County, Va., whose stomachs contained 3,000 leguminous seeds, mostly of tick trefoil and various species of bush clover. Pigeon grass, which is extremely common and mischievous in truck land, is a favorite food. No less than 5,000 seeds of this troublesome plant were found in the stomach of a bird shot in October, 1902, at Pinebrook, N. J. Finally, a Bob-white taken on Christmas Day, 1901, at Kinsale, Va., was discovered to have eaten 10,000 seeds of that abundant and obnoxious pest of the garden, the pigweed.

" A careful computation of the total amount of weed seed the Bob-white is capable of destroying is surprising in the magnitude of its result. In the state of Virginia it is safe to assume that from September 1 to 30, the season when the largest proportion of weed seed is consumed by birds, there are four Bob-whites to the square mile, or 169,800 in the entire state. The crop of each of these birds will hold half an ounce of seed; and, as at each of the two daily meals weed seed constitutes at least half the contents of the crop, or a quarter of an ounce, a half-ounce daily is certainly consumed by each bird. On this very conservative basis the total consumption of weed seed by Bob-whites from September 1 to April 30 in Virginia amounts to 573 tons.

" The Bob-white is insectivorous as well as granivorous. Insects are eaten during every month of the year, and amount to 14.93 per cent of the food for the year as a whole. From May to August, inclusive, when insects are most numerous, the percentage for the period rises to 31.5 per cent. The variety of insect food is large. In the present investigation 116 species of insects have been noted as entering into the diet, a number that will probably be greatly augmented by further knowledge. Furthermore, the proportion of injurious insects habitually eaten by the Bob-white makes its service as a destroyer of insects more valuable than those of many birds whose percentage of insect food, though greater, includes a smaller proportion of injurious species. Conspicuous among the pests which the Bob-white destroys are the potato beetle, the 12-spotted cucumber beetle, the bean leaf-beetle, the squash ladybird, wireworms and their beetles, May-beetles, such weevils as the corn billbug, the imbricated snout-beetle, the clover leaf weevil, and the Mexican cotton boll-weevil, the striped garden caterpillar, the army-worm, the cotton worm, the boll worm, various species of cutworms, the corn-louse ant, the red-legged grasshopper, the Rocky Mountain locust, and the chinch bug. Some of these pests are relished, for a dozen army-worms or cutworms are frequently eaten at a meal. Thirty Rocky Mountain locusts have been found in a single crop. Weevils are greatly sought after, 47 cotton boll-weevils having been eaten in a morning by one Bob-white. Striped cucumber beetles are destroyed by the score, potato beetles by the hundred, and chinch bugs by the tablespoonful."

Dr. Judd finds that the grain forms only one-fourth of the food, corn and wheat being preferred (corn, 19 per cent; wheat, 3 per cent); but that this was almost entirely obtained by gleaning among the stubble, not a single sprouting kernel having been found among the crops and stomachs examined.

Although 8½ per cent of the food consists of fruit, this is largely taken during December, and consists chiefly of sumac berries. Leaves and buds are only a small portion of its food, and these are principally of yellow sorrel, sheep sorrel, and red and white clover.

From its life in the woods the **Ruffed Grouse** or **Partridge** (*Bonasa umbellus umbellus*) is not of as direct economic importance as the Quail. Dr. A. K. Fisher of the Biological Survey finds (Weed and Dearborn, "Birds in their Relation to Man," pp. 224-6), that they are "very fond of grasshoppers and crickets," caterpillars also often entering into their diet. "Beechnuts, chestnuts, and acorns of the chestnut and white oaks are also common articles of food. Among berries, early in the season, the blackberries, blueberries, raspberries, and elderberries are eaten with relish, while, later in the year, wintergreen, partridge-berry, with their foliage, sumach-berries (including those of the poisonous species), cranberries, black alder, dogwood, nanny-berries, and wild grapes form their chief diet. In the fall the foliage of plants often forms a large part of their food, that of clover, strawberry, buttercup, wintergreen, and partridge-berry predominating. In the winter these birds feed on the buds of trees, preferring those of the apple tree, ironwood, black and white birch, and poplar.

"In isolated cases Ruffed Grouse cause some damage to fruit trees by eating the buds in winter. The extent of the injury which a grouse is capable of doing in a season may be estimated from the contents of a crop examined by us. It was taken from a female shot in January, and contained three hundred and forty-seven apple-tree buds, eighty-eight maple buds, and twelve leaves of sheep laurel. This was, of course, a single meal; and, as two such meals are eaten per day, it must be reckoned as half the daily consumption.

"One of the crops of four birds killed during the latter part of September and subjected to the same scrutiny showed barberries five per cent, sumac seeds twenty per cent, and apple pulp twenty per cent. Another contained ten per cent of mushrooms and ninety per cent of red-humped oak caterpillars (*Edema albifrons*). The other two were shot from the same flock at the same time. Their crops were packed with the oak caterpillars above mentioned and white-oak acorns, the ratios being sixty per cent and seventy-seven per cent of caterpillars, against forty per cent and twenty-three per cent of acorns, respectively." (Weed and Dearborn.)

This habit of eating the buds of trees probably does little harm, and is more than offset by the diet of the young in the spring, which appears to be almost wholly insectivorous, judging from the few published records.

## PIGEONS.

### *Columbidæ.*

The **Passenger Pigeon** (*Ectopistes migratorius*) is so near extinction that we need only regret its loss without discussing its economic value.

The **Mourning Dove** (*Zenaidura macroura carolinensis*), however, though not abundant with us, is of such great value as a weed destroyer that a quotation from Dr. Judd's paper on "Birds as Weed Destroyers," in the Year Book of the Department of Agriculture for 1898, will not be out of place in this report as evidence that our turtle dove's chief usefulness is not as game.

"It is pre-eminently a seed eater, and, although at times turning its attention to grain, it nevertheless consumes an enormous amount of weed seed. The crop of one dove secured in a rye field in Warner, Tennessee, contained 7,500 seeds of *Oxalis stricta.* Just outside the District of Columbia the bird has been seen feeding in fields overgrown with pigeon grass and ragweed, and especially in old cornfields, where smartweed and bindweed formed tangles of sufficient extent to injure the crop. In the Eastern States it has a peculiar habit of picking up pokeweed seeds and crushing them in its muscular stomach. Several weeds belonging to the genera *Lithospermum, Oxalis,* and *Euphorbia* are also utilized as food to a somewhat lesser extent. In California the dove feeds upon the seeds of a leguminous weed, known as turkey mullein (*Eremocarpus setigerus*). The habit is so well known in some localities that a botanist upon inquiring how he could collect some seeds of this plant was advised to shoot a few doves and open their crops."

## FALCONS, HAWKS, and EAGLES.

### *Falconidæ, Buteonidæ,* and *Pandionidæ.*

As regard usefulness our **Hawks** may be roughly grouped in two classes: the sailing, rather slow-flying hawks, which are beneficial; and the darting, swift-flying hawks, which are injurious.[1] This of course is not invariably true, but it is true in the main, and perhaps may save some Buteo or Marsh Hawk, who pays rent for its nest in the woods or meadow by incessant warfare on mice, from paying the penalty for the attacks of the Sharp-shinned and Cooper's Hawks on the poultry yard. Sportsmen have always held all forms of hawks evil and acted accordingly, shooting them indiscriminately, forgetting that the few birds some of them may take from the coveys of quail or partridge may be more than balanced by the usefulness of others; while the farmers, remembering lost chickens, are loth to believe that only two species of our common hawks are given to raids on domestic fowls, the others only seeking them when pressed for food. For the evil done by a few species, the Hawks and the Owls have been held up as enemies whose destruction should bring reward, and laws to this effect have been passed in different states. But after these laws have remained on the statute books for varying periods, with no advantage except to the few who make a business of collecting bounties — one county in Pennsylvania having paid out in a year over $5,000 in this manner,— they are usually repealed; and now many states protect all but a few of these birds. A very exhaustive study of the food of the Hawks and Owls of the United States was made some years ago by the Department of Agriculture, and the results given to the public in a special bulletin by Dr. A. K. Fisher under the title, "The Hawks and Owls of the United States in their Relation to Agriculture." This valuable work is now out of print, but some of its more important features relative to our Hawks and Owls are here given, together with a few personal investigations on this subject.

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[1] The Sparrow Hawk (*Falco sparverius sparverius*) must be excepted in the condemnation passed upon species related to it.

Dr. C. H. Merriam, Chief of the Biological Survey, in transmitting this work to the Secretary of Agriculture, states that in its preparation the contents of about 2,700 stomachs of these birds were examined.

"The result proves that a class of birds commonly looked upon as enemies to the farmer, and indiscriminately destroyed whenever occasion offers, really rank among his best friends, and with few exceptions should be preserved, and encouraged to take up their abode in the neighborhood of his home. Only six of the seventy-three species and subspecies of hawks and owls of the United States are injurious. Of these, three are so extremely rare they need hardly be considered, and another (the Fish Hawk) is only indirectly injurious, leaving but two (the Sharp-shinned and Cooper's Hawks) that really need be taken into account as enemies to agriculture. Omitting the six species that feed largely on poultry and game, 2,212 stomachs were examined, of which 56 per cent contained mice and other small mammals, 27 per cent insects, and only 3½ per cent poultry or game birds. In view of these facts the folly of offering bounties for the destruction of hawks and owls, as has been done by several states, becomes apparent, and the importance of an accurate knowledge of the economic status of our common birds and mammals is overwhelmingly demonstrated."

Of our hawks there are only five that feed habitually on birds; and, of these two, the **Duck Hawk** (*Falco peregrinus anatum*) and **Goshawk** (*Astur atricapillus atricapillus*) are so rare that they may be left out of consideration.

The **Sharp-shinned Hawk** (*Accipiter velox*), though diminutive in size, is large in courage, and is the true "Chicken Hawk," and probably feeds entirely on birds when obtainable. "When a pair of Sharp-shinned Hawks find a farm where young chickens are easily obtained, they generally visit it until the supply gives out, or they themselves meet a tragic death. Nuttall speaks of a single bird which came every day to a farmhouse until it had carried away between twenty and thirty young chickens." (Fisher, "Hawks and Owls of the United States in their Relation to Agriculture.")

Its only redeeming trait is that it kills English Sparrows as well as other birds.

Of 159 stomachs reported by Dr. Fisher, 6 contained poultry or game birds; 99, other birds; 6, mice; 5, insects; and 52 were empty. Of two stomachs examined by Mr. G. V. Smith in Connecticut, one contained a sparrow, and the other a grasshopper. Of 21 examined by the author, 12 were empty; and the other 9 all contained birds, among which were recognized one Flicker, one Goldfinch, sparrows, and warblers.

Similar in plumage and habits to the Sharp-shinned, but slightly larger, **Cooper's Hawk** (*Accipiter cooperi*) is also to be condemned. This is the true "Hen Hawk," its food consisting largely of poultry, domestic pigeons, and game; and for its misdeeds many a hapless buzzard-hawk has been killed.

Of 133 stomachs reported by Dr. Fisher, 34 contained poultry or game birds; 52, other birds; 11, mammals; 1, a frog; 3, lizards; and 29 were empty. Dr. Coues says, "it attacks and destroys hares, grouse, teal, and even the young of larger ducks" ("Birds of the Northwest," p. 338). Dr. B. H. Warren writes: "Of the thirty-four birds which I have examined, sixteen showed the food taken to have been chickens; ten revealed small birds — sparrows, warblers, and meadowlarks; two, quail; one, bull-frog; three, mice and insects; two, hair and other remains of small quadrupeds" ("Birds of Pennsylvania," 1888, p. 80). Three stomachs examined by the author were all empty, but one bird was shot while killing a chicken.

The **Pigeon Hawk** (*Falco columbarius columbarius*) must also be classed among the injurious species, its food consisting chiefly of birds; but it occurs with us only as a by no means common spring and fall migrant.

Of 56 stomachs reported by Dr. Fisher, 2 contained poultry; 41, small birds; 2, mice; 16, insects; and 5 were empty. Pigeons and flickers, robins, and the various blackbirds are favorites in the Pigeon Hawk's dietary, and it has been known to kill a ptarmigan and a domestic hen. Three stomachs examined by the author contained birds.

The only other Hawk not distinctly beneficial is the **Osprey** or **Fish Hawk** (*Pandion haliaëtus carolinensis*). Its food consists wholly of fish; but, as the latter are not generally species used by us for food, it cannot be considered harmful.

The **Marsh Hawk** (*Circus hudsonius*), distinguished by its white rump, spends its time beating back and forth over the meadows after field mice, although it may have recourse to small birds or chickens when driven by hunger. A nest containing four young and one hatching egg, was found by the author on June 12, 1900, in a meadow at Warren not far from a farmhouse where there were many young chickens. These chickens were not disturbed until after June 15th, when the male was shot and sent to the author. Its stomach contained a mouse. Three days later came the female and one of the young with the statement that, as soon as the male was killed, the female began to prey on the chickens. The proofs of this were the remains of a young chicken and the shell of a robin's egg in the stomach of the female, while that of the young bird contained a mouse.

Of 124 stomachs reported by Dr. Fisher, 7 contained poultry or game birds; 34, other birds; 57, mice; 22, other mammals; 7, reptiles; 2, frogs; 14, insects; 1, indeterminate matter; and 8 were empty. Mr. E. T. Judd found three birds in the stomach of one shot in North Dakota, and Mr. G. V. Smith found birds in two he shot near New Haven. Of 11 stomachs examined by the author, 4 were empty; 5 contained mammals; 3, birds; 1, a snake; and 1, a robin's egg.

Our Buzzard-hawks — **Red-tailed, Red-shouldered,** and **Broad-winged** (*Buteo borealis borealis, lineatus lineatus,* and *platypterus*) are the birds we see sailing in wide circles high over head. They are rather sluggish in temperament, seldom catch birds and still more rarely poultry, and are among the most useful allies the agriculturist possesses in his contest with field mice and other injurious small mammals. The Broad-winged Hawk also devours numbers of the large caterpillars so destructive to forests and shade trees. The Red-tailed and Red-shouldered Hawks stay with us all the year, breeding in tall trees; the former, on the hills of the interior, the latter, in the marshy woodlands near the coast; but the Broad-winged is common only for a limited time in the fall.

Of 562 stomachs of the **Red-tailed Hawk** reported by Dr. Fisher, 54 contained poultry or game birds; 51, other birds; 278, mice; 131, other mammals; 37, batrachians or reptiles; 47, insects; 8, crawfish; 1, centipeds; 13, offal; and 89 were empty. From this study Dr. Fisher has found that at least 85 per cent of the food of this hawk is composed of injurious rodents; which certainly shows it deserves protection. Of 173 stomachs examined by Dr. Warren, 128 contained mice, and once he found 7 mice in one stomach ("Birds of Penn.," 1888, p. 86). Mr. C. L. Rawson has reported finding near Norwich in one nest of this hawk the remains of 9 red squirrels, and of 7 in another (*Ornithologist and Oölogist,* Vol. 8, 1883, p. 17). Of five stomachs examined by the author, one was empty, and four contained mammals, chiefly squirrels.

Regarding the **Red-shouldered Hawk,** our most common breeding species near the coast, Dr. Fisher writes, "It is extremely improbable that this slow-flying Hawk often captures birds, except such as are disabled," and quotes a letter from Mr. J. Alden Loring, of Owego, Tioga County, New York: "The pair reared their young for two years in a small swampy piece of woods about 50 rods from a poultry farm which contained 800 young chickens and 400 ducks, and the keeper told me he had never seen hawks attempt to catch one." Dr. Fisher reports that, of 220 stomachs examined, 3 contained poultry; 12, other birds; 102, mice; 40, other mammals; 20, reptiles; 39, batrachians; 92, insects; 16, spiders; 7, crawfish; 1, earthworms; 2, offal; 3, fish; and 14 were empty. Dr. Warren found field mice in 43 of 57 stomachs examined. Of 9 stomachs examined by the author, 5 were empty; 3 contained mammals; 1, a snake; and 2, insects.

About the **Broad-winged Hawk,** Dr. Fisher reports that, of 65 stomachs examined, 2 contained small birds; 15, mice; 13, other mammals; 11, reptiles; 13, batrachians; 30, insects; 2, earthworms; 4, crawfish; and 7 were empty. Of 12 stomachs examined by Dr. Warren, 4 contained mice; 3, small birds; 4, frogs; 1, crawfish and traces of coleopterous insects. Of 6 stomachs examined by the author, 2 contained mammals; and all 6, insects, among which were cicadas, katydids, grasshoppers, beetles, and various large caterpillars.

The **Rough-legged Hawk** (*Archibuteo lagopus sancti-johannis*) occurs with us only as a rather rare winter resident, but is altogether useful in its feeding habits. All of eleven stomachs examined by Dr. Warren contained field mice; while, of 49 stomachs reported by Dr. Fisher, 40 contained mice; 5, other mammals; 1, lizards; 1, insects; and 4 were empty.

The **Golden Eagle** (*Aquila chrysaëtos*) is only a straggler with us; and the **Bald Eagle** (*Haliæetus leucocephalus*) is so rare that its food is of little importance. It feeds largely on fish, carrion, small mammals, and occasionally waterfowl.

The little **Sparrow Hawk** (*Falco sparverius sparverius*), chiefly distinguishable from the Sharp-shinned by its long and pointed wings and its habit of hovering in the air, is one of our most useful birds, as its food is principally grasshoppers. Of 320 stomachs reported by Dr. Fisher, 1 contained a game-bird; 53, other birds; 89, mice; 12, other mammals; 12, reptiles or batrachians; 215, insects; 29, spiders; and 29 were empty. Of 65 stomachs examined by Dr. Warren, 31 contained field mice; 23, grasshoppers and beetles; 7, small birds; 2, meadowlarks; 1, a mouse and small birds; and 1, insects and small birds. Of 10 stomachs examined by the author, 2 were empty; 3 contained mammals, chiefly mice; and 5, insects, largely grasshoppers.

## OWLS.

### *Strigidæ.*

Of the six **Owls** occurring regularly in Connecticut, the habits of only one — the **Great Horned Owl** (*Bubo virginianus virginianus*) — are such as to deserve ostracism. Its strength, ferocity, and courage are great, and it has well been called the tiger of the air. One who has seen the fury gleaming from the eyes of a pair of these birds when he is at their nest has had an experience he will not soon forget. Both mammals and birds are its prey, and large ones at that; rabbits, squirrels, and skunks among the former, and quail, ducks, partridges, and domestic fowls among the latter, are the chief sufferers. Large hawks, crows, and other owls also are often killed and eaten. Dr. Merriam states: "It feeds on the larger game (hares, grouse, and the like), not forgetting the poultry yard, and seems particularly fond of turkeys, of which it seldom touches more than the head, if there are a plenty about. Indeed, I have known one to kill and decapitate three turkeys and several hens in a single night, leaving the bodies uninjured and fit for the table." (Merriam, "Birds of Connecticut," p. 67.) Dr. Fisher calls this Owl the most destructive to poultry of all our birds of prey, with the possible exception of the Goshawk and Cooper's Hawk, and quotes Dr. P. R. Hoy as writing, "The specimen in the collection of the Academy was known to carry off from one farm, in the space of a month, not less than twenty-seven individuals of various kinds of poultry before it was shot." Of the 127 stomachs reported by him, 31 contained poultry or game birds; 8, other birds; 13, mice; 65, other mammals; 1, a scorpion; 1, fish; 10, insects; and 17 were empty. Of 16 examined by Dr. Warren, 11 contained poultry; 2, rabbits; 2, mice; 1, a mammal; and 1, insects. Of 3 stomachs examined by the author, 1 was empty; 1 contained a mass of bones and feathers, including those of a Robin and Crow; and 1, many small birds. In a nest containing three young just hatched, visited by him on March 9, 1904, was a dead Screech Owl and three mice. The bodies of 113 rats, chiefly killed within the last ten days, have been found under a nest of this owl containing young. Little claim has this bird to our protection, but it is rare through most of the state.

Our other five Owls are all useful, some of them almost exclusively so, and should be afforded full protection.

The **Barred Owl** (*Strix varia varia*) is next in size to the Great Horned Owl, and much more common, especially near the coast. While its food is largely the same as that of the last species, its incursions into the poultry yard are less frequent, its pursuit of game less eager, and its relish for mice and other injurious mammals far greater. A taste for small owls frequently indulged in by this species must be counted against it, as these owls are altogether useful. Dr. Fisher reports finding the remains of small owls in seven stomachs of these birds, and quotes two incidents of Screech Owls having thus been found by others. Several times in pellets, probably of this owl, found in the woods near New Haven, the author has noticed feathers of Screech and Saw-whet Owls, and once found the latter in the stomach of a Barred Owl. Of 109 stomachs reported by Dr. Fisher, 5 contained poultry or game; 13, other birds; 46, mice; 18, other mammals; 4, frogs; 1, a lizard; 2, fish; 14, insects; 2, spiders; 9, crawfish; and 20 were empty. Of 8 stomachs examined by Dr. Warren, 4 contained mice; 2, other mammals; 2, poultry; 2, other birds; and 4, beetles. Of 14 examined by the author, 7 were empty; 6 contained mammals — mice and squirrels; and 1, a Saw-whet Owl.

The **Short-eared Owl** (*Asio flammeus*) is with us only in the fall and early spring, when it inhabits our marshes. The chief food of this bird is mice, and there are many accounts of the manner in which these owls have flocked to the infested district, when different parts of Europe have suffered with plagues of these animals. Of 101 stomachs reported by Dr. Fisher, 11 contained small birds; 77, mice; 7, other mammals; 7, insects; and 14 were empty. Of 11 stomachs reported by Dr. Warren, all contained mice; and 2, beetles. Three stomachs examined by the author in Alaska contained either mice or shrews; and one examined by Mr. E. T. Judd in North Dakota contained a mouse and grasshoppers.

But there is another side to this picture that should not be forgotten, useful on the whole as the Short-eared Owl must be considered. One stomach of a California bird examined by the author contained a blackbird; and the stomachs of four Connecticut birds held only birds, including a Meadowlark and sparrows; while at the spots these owls frequent on our salt marshes he has found many evidences of their destructiveness to birds, including once feathers of a Yellow Rail, and pellets containing those of the Meadowlark, Robin, and Towhee. Another serious deviation from a mice diet has been reported by Mr. William Brewster (*Bulletin Nuttall Ornithological Club,* Vol. 4, 1879, p. 19). He found in June, 1870, a small colony of these owls living among the terns of Muskeget Island, and noticed in the grass of their retreat the remains of at least 100 terns that they had killed. The breast only had been eaten in each instance.

More consistently useful than either of these Owls is the **Long-eared Owl** (*Asio wilsonianus*); for its food is almost wholly field mice, as many as eight having been found in one stomach; and it is deserving of most thorough protection. It is by no means common through most of the state, and is usually shot at sight. Dr. Warren writes: "I have examined the stomachs of twenty-three Long-eared Owls, and found that twenty-two of them had fed only on mice; the other examination made of a specimen taken in the late spring, showed some beetles and portions of a small bird." Dr. Fisher reports that, of 107 stomachs examined, 1 contained a game-bird; 15, other birds; 84, mice; 5, other mammals; 1, insects; and 15 were empty. Of 14 examined by the author, 6 were empty; the other 8 all contained mammals, chiefly mice; and 1, a small bird.

About the villages and orchards the little **Screech Owl** (*Otus asio asio*) is by far the most abundant of our owls, and undoubtedly helps in keeping down the number of English Sparrows, although mice and insects are the chief diet. It has been known to kill quail and woodcock, though rarely; and once sixteen horned pouts were found in the nest of this bird in the depth of winter. All authorities agree that its food in summer consists chiefly of insects. Mr. George C. Jones of Brookfield Center, Connecticut, writes in Dr. Fisher's work that he has found cutworms in the stomachs of the Long-eared Owl and this species, and believes these birds the most efficient exterminators of this pest so formidable to tobacco growers. Of 255 stomachs reported by Dr. Fisher, 1 contained poultry; 38, other birds; 91, mice; 11, other mammals; 2, lizards; 4, batrachians; 1, fish; 100, insects; 5, spiders; 9, crawfish; 2, scorpions; 2, earthworms; 7, miscellaneous material; and 43 were empty. Of 27 stomachs examined by Dr. Warren, 20 contained mice and insects; 5, small birds; and 2, small birds and insects. Of 7 examined by the author, 3 were empty; 3 contained mammals, chiefly mice; and 1, insects.

Our smallest owl, the **Saw-whet** or **Acadian** (*Cryptoglaux acadica acadica*) seems to be rare throughout the state, and has only been taken at all frequently during the winter. Many of those recorded have been found dead, apparently starved. Mice are almost its only food, although an entire flying squirrel has been reported in the stomach of this bird. Of 22 stomachs reported by Dr. Fisher, 17 contained mice; 1, a bird; 1, an insect; and 3 were empty. Of 4 stomachs examined by the author, 3 contained mice; and 1 was empty.

The **Snowy Owl** (*Nyctea nyctea*) is a rare winter resident in the state, most common near the seashore. Dr. Fisher finds it a useful bird. Of 38 stomachs examined by him, 2 contained game birds; 9, other birds; 18, mice; 2, other mammals; and 12 were empty.

## CUCKOOS.

### *Cuculidæ.*

Especially deserving of protection are our **Cuckoos,** the **Black-billed** (*Coccyzus erythrophthalmus*), and the **Yellow-billed** (*Coccyzus americanus americanus*); as they feed chiefly on the caterpillars that infest the trees of the woods and orchards, and are among the few birds that eat the hairy species. "In fact, cuckoos eat so many hairy caterpillars that the hairs pierce the inner lining of the stomach and remain there, so that, when the stomach is opened and turned inside out, it appears to be lined with a thin coating of fur." (Beal, "Some Common Birds in Relation to Agriculture.")

"The insect food of cuckoos consists of beetles, grasshoppers, cicadas, bugs, ants, wasps, flies, caterpillars, and spiders, of which grasshoppers and caterpillars constitute more than three-fourths. The great majority of the insects found in the stomachs were harmful kinds. Caterpillars, katydids, and tree crickets are exactly the prey that cuckoos might be expected to secure, from their peculiar method of hunting in foliage; while the large numbers of grasshoppers eaten furnish additional proof of the fact so often illustrated that birds are particularly fond of grasshoppers, and that species not naturally ground feeders become so during the grasshopper season.

"It is a matter of common observation that cuckoos feed largely on caterpillars; and stomach investigations not only confirm this, but show that, unlike most other birds, they eat freely of hairy and bristly species. Nearly half of the cuckoo's food was found to be caterpillars. An attempt was made to obtain an approximate idea of the actual number in the stomachs by counting the heads and jaws; but in many cases this was nearly impossible, as many of the insects were very young and the jaws consequently minute. The result of this estimate, however, showed that no less than 2,771 caterpillars were contained in 129 stomachs, or an average of more than 21 in each. If the whole number of stomachs (155) is considered, the average is reduced to 18; and it is absolutely certain that this is much below the actual number.

"During May and June, when tent caterpillars are defoliating the fruit trees, these insects constitute half of the Cuckoo's food. When Cuckoos visit the nest of the tent caterpillars they apparently eat as many of the occupants as possible. Most of the stomachs that contained the larvæ at all were filled with them, some having more than 100 individuals." (Beal, "The Food of Cuckoos.")

"An examination of the stomachs of 16 Black-billed Cuckoos, taken during the summer months, showed the remains of 328 caterpillars, 11 beetles, 15 grasshoppers, 63 sawflies, 3 stink-bugs, and 4 spiders." "Of the Yellow-billed Cuckoo, 21 stomachs, collected from May to October, inclusive, were examined. The contents consisted of 355 caterpillars, 18 beetles, 23 grasshoppers, 31 sawflies, 14 bugs, 6 flies, and 12 spiders. As in the case of the Black-billed Cuckoo, most of the caterpillars belonged to hairy species, and many of them were of large size." (Beal, "Some Common Birds in their relation to Agriculture.")

## KINGFISHERS.

### *Alcedinidæ.*

The **Belted Kingfisher** (*Ceryle alcyon*) feeds chiefly on small fish, the vast majority of which are of no economic value. Mice, frogs, and grasshoppers are also said to be occasionally captured, and the young are fed with various aquatic insects. (Weed and Dearborn, "Birds in their Relation to Man.") Its chief value, however, is an æsthetic one, the boldly marked form and noisy rattle adding interest to the shore of lake, river, and sound.

## WOODPECKERS.

### *Picidæ.*

Of the four **Woodpeckers** that now occur in any numbers in Connecticut, the **Yellow-bellied Sapsucker** (*Sphyrapicus varius varius*) is the only harmful species; and it is with us only as a tolerably common spring and fall migrant. This is the species that drills the series of small circular openings so often found on the trunks of apple trees, to eat the inner layer of bark and drink the sap that exudes into these tiny cups. Birches and the mountain ash are favorites with this bird, on account of their abundant sweet sap; and the trees are sometimes killed by too persistent tapping. In the Turtle Mountains of North Dakota the author has noticed that most of the larger birches that showed evidences of this bird's work were dead at the top. But not alone for the sap and bark does the sapsucker drill these holes; he has a choice feast from the insects that are attracted (Merriam, *Bulletin Nuttall Ornithological Club,* Vol. 4, 1879, p. 3). A certain amount of insect food is necessary to the species at least in youth; for young birds fed as exclusively as possible on a diet of maple syrup died with the symptoms of starvation, and the stomachs of eight adults shot in June and July were full of insects. (Bolles, *The Auk,* Vol. 8, 1891, p. 269, and Vol. 9, 1892, p. 119.)

Professor Beal reports that in 313 stomachs examined the vegetable part more than equaled the animal; 34.31 per cent of the entire food consisted of ants, the rest of the animal portion being wasps, beetles, flies, bugs, grasshoppers, crickets, and May-flies; while the chief items of the vegetable portion are fruit and cambium. (Beal, "Food of the Woodpeckers of the United States.")

Our commonest and smallest **Woodpecker,** the **Downy,** (*Dryobates pubescens medianus*) is also the most useful. In 140 stomachs Prof. Beal reports there was found 74 per cent of insects, 25 per cent of vegetable matter, and 1 per cent of mineral matter or sand. "The ants constitute almost one-third of all the animal food, or about 23 per cent of the whole, indicating a very decided taste for this rather acid and highly flavored article of diet. Beetles stand a little higher in order of importance, amounting to about one-third of the entire insect food, or somewhat more than 24 per cent of all. Many of these belong to the family of May-beetles, a few were the predaceous ground beetles, but by far the greatest number were wood-boring larvæ — a fact showing that this little bird, while securing his dinner, is doing good work for the forest. One-fifth of the animal food, or 16 per cent of the total, consists of caterpillars, many of which apparently are wood-boring species; others are kinds that live on stems and foliage. Among insects the most interesting are the bugs (Hemiptera), which are represented in the stomachs by several species, notably by plant lice (Aphides), which in several instances were found in considerable quantities, amounting to 4 per cent of the whole food." (Beal, "Preliminary Report on the Food of Woodpeckers.")

In the vegetable food were found the seeds of different berries, including poison ivy. It thus becomes evident that these little birds are not engaged in harming the trees, when we see them pecking from limb to limb, but hunting for wood-boring insects and the like.

The great usefulness of the Downy Woodpecker has been in recent years abundantly proved by more extended observations of the Biological Survey. The contents of 723 stomachs consisted of 76.05 per cent of animal matter and only 23.95 per cent of vegetable. "The foregoing discussion of the Downy Woodpecker shows it to be one of our most useful species. The only complaint against the bird is on the score of disseminating the poisonous species of *Rhus*. However, it is fortunate that the bird can live on this food when it is difficult to procure anything else. The insect food selected by the Downy is almost all of species economically harmful." (Beal, "Food of the Woodpeckers of the United States.")

The food of the **Hairy Woodpecker** (*Dryobates villosus villosus*) is much the same as that of the Downy, but the vegetable percentage is somewhat greater.

The **Flicker**, or **Yellow-hammer** (*Colaptes auratus luteus*), the largest of our common woodpeckers and the most abundant near the coast in the fall, lives largely on ants, over 2,000 having been found in each of two stomachs by Professor Beal. As ants protect and help to spread plant lice of various species, their destruction by the Flicker is advantageous. Professor Beal found, in 230 stomachs examined, 56 per cent of animal matter, 39 per cent of vegetable, and 5 per cent of mineral. More than three-fourths of the animal matter consisted of ants, but spiders, beetles, and myriapods were also present. Of the vegetable matter, corn and buckwheat were found in only six stomachs, the rest consisting of various berries and seeds, many of them those of weeds. In a later report, Professor Beal states that 60.92 per cent of the contents of 684 stomachs was animal matter, and 39.08 per cent vegetable. "It eats only a few predaceous ground beetles. The remainder of the animal food is entirely of harmful species. In its vegetable diet, grain and fruit are the only useful products eaten, and the quantities are insignificant. The bird, like many others, has the bad habit of sowing broadcast the seeds of the poison *Rhus*, but there seems no remedy for this." (Beal, "Food of the Woodpeckers of the United States.")

## NIGHTHAWKS and WHIP-POOR-WILLS.

### *Caprimulgidæ.*

The **Whip-poor-will** (*Antrostomus vociferus vociferus*) and the **Nighthawk** (*Chordeiles virginianus virginianus*) subsist almost entirely on the different night-flying insects. Moths, beetles, and injurious grasshoppers form a large portion of the food of the Whip-poor-will (Weed and Dearborn); and Mr. Nash found the stomach of one filled with large wingless ants (Nash, "Birds of Ontario"). Flying Nighthawks shot in the evening by the author in North Dakota have almost invariably had the entire throat crowded full of insects, and the thick coating of fat on these birds shows how abundant they find this food. "It is a great insect eater, its food consisting of May-flies, dragon-flies, beetles of many kinds, water-boatmen, scorpion-flies, bugs of various sorts, and many grasshoppers. From seven Nebraska specimens Professor Aughey took three hundred and forty-eight Rocky Mountain locusts, an average of forty-nine to each bird. An Arkansas specimen examined by F. L. Harvey contained more than six hundred insects — gnats, beetles, flies, ants, and grasshoppers. Professor Herrick has found that the young are fed largely on firefly beetles." (Weed and Dearborn.) Yet this bird, whose whole existence is given to keeping insect pests under, is shot in wantonness by almost every boy with a gun, until it is now seldom seen, though formerly common in every rocky pasture throughout the state.

## SWIFTS.

### *Micropodidæ.*

The **Chimney Swift** (*Chætura pelagica*) also feeds entirely on insects; and the number of these it must capture each day is indicated by the writhing mass in its throat, when it has coursed an hour or so through the air. "Their food is varied, probably consisting of almost all the flying insects with which they come in contact. Three specimens studied by Professor S. A. Forbes had eaten ants, moths, ground beetles, rove-beetles, plant beetles, flies, bugs, and spiders. The young are fed largely upon grasshoppers when these are abundant, and at other times on various kinds of insects." (Weed and Dearborn.)

## HUMMINGBIRDS.

### *Trochilidæ.*

Although the few small insects which our solitary **Hummingbird**, the **Ruby-throated** (*Archilochus colubris*), eats while sipping the honey from flowers, or the sap at the cups of the Sapsucker, may not be of economic importance, its beauty should certainly gain our protection.

## FLYCATCHERS.

### *Tyrannidæ.*

As their name implies, the **Flycatchers** are insect eaters. These they obtain chiefly by darting from a limb or post and seizing them in the air, but occasionally hunt for them on the ground. Only five species of them are common enough with us to be of any economic importance, and of these the **Kingbird** (*Tyrannus tyrannus*) is the largest and most numerous. Locally known as "Bee Martin" on account of its supposed fondness for bees, this bird has obtained an evil reputation that seems to be undeserved. Mr. Nash quotes a Mr. Thaddeus Smith as writing, "I have been here over thirty years, and at one time made the science of apiculture a special study, raising choice

Italian queens, etc. Kingbirds are here every season, and are to be seen around my beehives. Years ago I killed some and examined their stomachs, and found them full of bees, but nearly every bee in them was a *drone;* I found *only one worker bee.* You know the drones have no sting, and, as their name implies, they are of no use in the hive. They are the male bees, and their only use is to fertilize the queen bee. The only damage the Kingbird can do is that they might sometimes catch the young queen while on her wedding flight, as her size and slow flight make her quite conspicuous. But the possibility of this happening is so slight that I never now shoot the Kingbird." (Nash, " Birds of Ontario in relation to Agriculture.")

" The Kingbird manifests its presence in many ways. It is somewhat boisterous and obtrusive, and its antipathy for hawks and crows is well known. It never hesitates to give battle to any of these marauders, no matter how superior in size, and for this reason a family of Kingbirds is a desirable adjunct to a poultry yard. On one occasion in the knowledge of the writer, a hawk which attacked a brood of young turkeys was pounced upon and so severely buffeted by a pair of Kingbirds, whose nest was near by, that the would-be robber was glad to escape without his prey. Song birds that nest near the Kingbird are similarly protected."

" The Biological Survey has made an examination of 281 stomachs collected in various parts of the country, but found only 14 containing remains of honeybees. In these 14 stomachs there were in all 50 honeybees, of which 40 were drones, 4 were certainly workers, and the remaining 6 were too badly broken to be identified as to sex.

" The insects that constitute the great bulk of the food of this bird are noxious species, largely beetles — May beetles, click beetles (the larvæ of which are known as wireworms), weevils, which prey upon fruit and grain, and a host of others. Wasps, wild bees, and ants are conspicuous elements of the food, far outnumbering the hive bees. During summer many grasshoppers and crickets, as well as leaf-hoppers and other bugs, are also eaten. Among the flies were a number of robber flies — insects which prey largely upon other insects, especially honeybees, and which have been known to commit in this way extensive depredations. It is thus evident that the Kingbird by destroying these flies actually does good work for the apiarist. Nineteen robber flies were found in the stomachs examined; these may be considered more than an equivalent for the four worker honeybees already mentioned. A few caterpillars are eaten, mostly belonging to the group commonly known as cutworms, all the species of which are harmful. About 10 per cent of the food consists of small native fruits, comprising some twenty common species of the roadsides and thickets, such as dogwood berries, elderberries, and wild grapes. The bird has not been reported as eating cultivated fruit to an injurious extent; and it is very doubtful if this is ever the case, for cherries and blackberries are the only ones that might have come from cultivated places, and they were found in but few stomachs.

"Three points seem to be clearly established in regard to the food of the Kingbird — (1) that about 90 per cent consists of insects, mostly injurious species; (2) that the alleged habit of preying upon honeybees is much less prevalent than has been supposed, and probably does not result in any great damage; and (3) that the vegetable food consists almost entirely of wild fruits, which have no economic value. These facts taken in connection with its well-known enmity for hawks and crows, entitle the Kingbird to a place among the most desirable birds of the orchard or garden." (Beal, "Some Common Birds in Relation to Agriculture.")

The **Phœbe** (*Sayornis phœbe*), according to Professor Beal "subsists almost exclusively upon insects, most of which are caught upon the wing. An examination of 80 stomachs showed that over 93 per cent of the year's food consists of insects and spiders, while wild fruit constitutes the remainder. The insects belong chiefly to noxious species, and include many click beetles, May beetles, and weevils. Grasshoppers in their season are eaten to a considerable extent, while wasps of various species, many flies of species that annoy cattle, and a few bugs and spiders are also eaten regularly. It is evident that a pair of phœbes must materially reduce the number of insects near a garden or field, as the birds often, if not always, raise two broods a year, and each brood numbers from four to six young.

"The vegetable portion of the food is unimportant, and consists mainly of a few seeds, with small fruits, such as wild cherries, elderberries, and juniper berries. The raspberries and blackberries found in the stomachs were the only fruits that might have belonged to cultivated varieties, and the quantity was trifling.

"There is hardly a more useful species than the Phœbe about the farm, and it should receive every encouragement. To furnish nesting boxes is unnecessary, as it usually prefers a more open situation, like a shed, or a nook under the eaves, but it should be protected from cats and other marauders." (Beal, "Some Common Birds in Relation to Agriculture.")

The **Wood Pewee** (*Myiochanes virens*) was found by Professor King to feed largely on small beetles and dipterous insects, including large crane-flies; and the **Least Flycatcher** (*Empidonax minimus*) to eat beetles, Diptera, and Hymenoptera. (Chapman, "Economic Value of Birds to the State.")

Of the Least Flycatcher (*Empidonax minimus*) Professor Forbush says, "Like all Flycatchers, this species catches flies, among them the common house fly, and also some useful parasitic flies. It is by no means confined to such food, however, but is particularly destructive to small beetles in flight, and in this respect it is most useful. It captures many moths, particularly those species that fly by day, as the gypsy moth; but it also picks up many which are stirring only very early in the morning or at evening. The bird watches for caterpillars, and, when it sees one stir, flies from its perch and snaps up the luckless creature. The bird, in common with other Flycatchers, picks up many caterpillars that, to escape Warblers and other enemies, spin down on their webs or drop from the trees. The greatest service our little Flycatcher renders to man consists of the destruction of such orchard pests as boring beetles, bark beetles, the fly of the railroad worm, codling moths, gipsy moths, cankerworms, and other caterpillars." (Forbush, "Useful Birds and their Protection.")

## LARKS.

### *Alaudidæ.*

Our **Horned Lark** (*Otocoris alpestris alpestris*) feeds almost entirely on seeds of various weeds. One examined by Dr. Judd had in the stomach "a bit of a kernel of corn, 4 seeds of lamb's-quarters, 8 of crab-grass, 10 of bastard pennyroyal, and 12 of ragweed" (Judd, "Birds of a Maryland Farm").

## CROWS and JAYS.

### *Corvidæ.*

Of the **Blue Jay** (*Cyanocitta cristata cristata*) Professor Beal says, "Ornithologists and field observers in general declare that a considerable portion of its food in spring and early summer consists of the eggs and young of small birds, and some farmers accuse it of stealing corn to an injurious extent in the fall. While there may be some truth in these accusations, they have almost certainly been exaggerated. No doubt many jays have been observed robbing nests of other birds, but thousands have been seen that were not so engaged.

"In an investigation of the food of the Blue Jay, 292 stomachs were examined, which showed that animal matter comprised 24 per cent and vegetable matter 76 per cent of the bird's diet. So much has been said about the nest-robbing habits of the Jay that special search was made for traces of birds or birds' eggs in the stomachs, with the result that shells of small birds' eggs were found in three, and the remains of young birds in only two stomachs.

"Such negative evidence is not sufficient to controvert the great mass of testimony upon this point, but it shows that the habit is not so prevalent as has been believed. Besides birds and their eggs, the Jay eats mice, fish, salamanders, snails, and crustaceans, which altogether constitute but little more than 1 per cent of its diet. The insect food is made up of beetles, grasshoppers, caterpillars, and a few species of other orders, all noxious, except some 3½ per cent of predaceous beetles. Thus something more than 19 per cent of the whole food consists of harmful insects. In August the Jay, like many other birds, turns its attention to grasshoppers, which constitute nearly one-fifth of its food during that month. At this time, also, most of the other noxious insects, including caterpillars, are consumed, though beetles are eaten chiefly in spring.

"The vegetable food is quite varied, but the item of most interest is grain. Corn was found in 70 stomachs, wheat in 8, and oats in 2 — all constituting 19 per cent of the total food.

Corn is evidently the favorite grain, but a closer inspection of the record shows that the greater part was eaten during the first five months of the year, and that very little was taken after May, even in harvest time, when it is abundant. This indicates that most of the corn is gleaned from the fields after harvest, except what is stolen from cribs or gathered in May at planting time.

"The Jay's favorite food is mast (i. e., acorns, chestnuts, chinquapins, etc.), which was found in 158 of the 292 stomachs, and amounted to more than 42 per cent of the whole food. In September corn formed 15 and mast 35 per cent; while in October, November, and December corn dropped to an almost inappreciable quantity, and mast amounted to 64, 82, and 83 per cent, respectively. And yet in these months corn is abundant and everywhere easily accessible. The other elements of food consist of a few seeds and wild fruits, among which grapes and blackberries predominate.

"The results of the stomach examination show (1) that the Jay eats many noxious insects; (2) that its habit of robbing the nests of other birds is much less common than has been asserted; and (3) that it does little harm to agriculture, since all but a small amount of the corn eaten is waste grain." (Beal, "Some Common Birds in Their Relation to Agriculture.")

In another paper —"The Blue Jay and its Food,"— Professor Beal cites several instances of the Jay destroying the eggs or young of smaller birds; and we agree with the verdict of Mr. Frank M. Chapman: "Personally, my attitude toward the Jay is that which I hold in regard to the Crow. It is not unusual for the Jay to eat birds' eggs, and in so doing he does an injury which the good deeds to his credit are far from balancing. As with the Crow, any one of the insect or seed eating birds killed by a Jay would doubtless have been more desirable than the Jay itself; and, where a single Jay, as often happens, destroys a whole nestful of eggs, it becomes a positively injurious species. I believe, therefore, that the Blue Jay is no more deserving of protection than is the Crow. Both birds, however, are far too interesting to be exterminated, but no steps should be taken which will result in their increase. Belonging to a family noted for the intelligence and adaptability of its members, Crows and Jays can adjust themselves to the changes incident to civilization far more readily than any of the birds which become their victims; and, in cases of this kind, man should help to restore nature's balance by according protection to the weaker species; not to their enemies." (Chapman, "Economic Value of Birds to the State.")

Regarding the **Crow** (*Corvus brachyrhynchos brachyrhynchos*), the evidence is about the same as with the Blue Jay; and it is probable that the good this bird does in destroying grasshoppers, cutworms, etc., is far outweighed by the evil in killing the young of insectivorous birds. "There are few birds so well known as the common Crow, and, unlike most other species, he does not seem to decrease in numbers as the country becomes more densely populated.

"The Crow is commonly regarded as a blackleg and a thief. Without the dash and brilliancy of the Jay, or the bold savagery of the Hawk, he is accused of doing more mischief than either. That he does pull up sprouting corn, destroy chickens, and rob the nests of small birds, has been repeatedly proved. Nor are these all of his sins. He is known to eat frogs, toads, salamanders, and some small snakes — all harmless creatures that do some good by eating insects. With so many charges against him, it may be well to show why he should not be utterly condemned.

"The examination of a large number of stomachs, while confirming all the foregoing accusations, has thrown upon the subject a light somewhat different from that derived solely from field observations. It shows that the bird's-nesting habit, as in the case of the Jay, is not so universal as has been supposed; and that, so far from being a habitual nest-robber, the Crow only occasionally indulges in that reprehensible practice. The same is true in regard to destroying chickens, for he is able to carry off none but very young ones, and his opportunities for capturing them are somewhat limited. Neither are many toads and frogs eaten; and, as frogs are of no great practical value, their destruction is not a serious matter; but toads are very useful, and their consumption, so far as it goes, must be counted against the Crow. Turtles, crayfishes, and snails, of which he eats quite a large number, may be considered neutral, while mice may be counted to his credit.

" In his insect food, however, the Crow makes amends for sins in the rest of his dietary, although even here the first item is against him. Predaceous beetles are eaten in some numbers throughout the season, but the number is not great. May beetles, dor-bugs, or June bugs, and others of the same family, constitute the principal food during spring and early summer, and are fed to the young in immense quantities. Other beetles, nearly all of a noxious character, are eaten to a considerable extent. Grasshoppers are first taken in May, but not in large numbers until August, when, as might be expected, they form the leading article of diet, showing that the Crow is no exception to the general rule that most birds subsist, to a large extent, upon grasshoppers in the month of August. Many bugs, some caterpillars, most cutworms, and some spiders are also eaten — all of them either harmful or neutral in their economic relations. Of the insect diet Mr. E. A. Schwarz says: 'The fact, on the whole, speaks overwhelmingly in favor of the Crow.'

" Probably the most important item in the vegetable food is corn, and by pulling up the newly sprouted seeds the bird renders himself extremely obnoxious. Observation and experiments with tame crows show that hard, dry corn is never eaten if anything else is to be had, and, if fed to nestlings, it is soon disgorged. The reason crows resort to newly planted fields is that the kernels of corn are softened by the moisture of the earth, and probably become more palatable in the progress of germination, which changes the starch of the grain to sugar. The fact, however, remains that crows eat corn extensively only when it has been softened by germination or partial decay, or before it is ripe and still 'in the milk.' Experience has shown that they may be prevented from pulling up young corn by tarring the seeds, which not only saves the corn, but forces them to turn their attention to insects. If they persist in eating green corn, it is not so easy to prevent the damage; but no details of extensive injury in this way have yet been presented, and it is probable that no great harm has been done.

" Crows eat fruit to some extent, but confine themselves for the most part to wild species, such as dogwood, sour gum, and seeds of the different kinds of sumac. They have also a habit of sampling almost everything which appears eatable, especially when food is scarce. For example, they eat frozen apples found on the trees in winter, or pumpkins, turnips, and potatoes which have been overlooked or neglected; even mushrooms are sometimes taken, probably in default of something better.

"In estimating the economic status of the Crow, it must be acknowledged that he does some damage, but, on the other hand, he should receive much credit for the insects which he destroys. In the more thickly settled parts of the country the Crow probably does more good than harm, at least when ordinary precautions are taken to protect young poultry and newly planted corn against his depredations. If, however, corn is planted with no provision against possible marauders, if hens and turkeys are allowed to nest and to roam with their broods at a distance from farm buildings, losses must be expected." (Beal, "Some Common Birds in Their Relation to Agriculture.")

"While, from the nature of the case, birds' eggs and young can form but a small portion of the annual food supply of the Crow, I believe it to be indisputable that during the nesting season they constitute a large percentage of the Crow's food. Nest-robbing is not occasional, but is the characteristic habit of the Crow. Not only do they eat eggs and young birds, but they feed their offspring on them. Doubtless few Crows live through May and June without preying on smaller birds, and the possibilities are that almost any one of the birds destroyed (either in the egg or out of it) is of greater economic value than the Crow. The Crow, therefore, in addition to the direct damage it may do our crops, robs us of the services of birds far more desirable than itself. Even if the Crow, aside from its cannibal-like propensities, was wholly beneficial, it would not, it seems to me, render us as great a service as would have been performed by the birds it destroys. In short, in my opinion, the Crow is one of the worst enemies of our small insectivorous and seed-eating birds, and as such it is undeserving of protection." (Chapman, "Economic Value of Birds to the State.")

## STARLINGS.

### *Sturnidæ.*

As the **Starling** (*Sturnus vulgaris*) is now so firmly settled along the coast as far east as New Haven that its distribution through the rest of the state seems only a matter of time, it is important for us to know whether we should welcome it, or are receiving another undesirable immigrant. The evidence appears on the whole to be adverse to the good character of this bird, and is thus given by Dr. T. S. Palmer: "The Starling (*Sturnus vulgaris*) of Europe and western Asia is one of the best-known birds of the Old World, and during late years has been increasing in numbers in the British Isles. It is sometimes accused of stealing fruit and destroying nests and eggs of other birds, but in its native home it seems to be beneficial rather than otherwise. Comparatively little accurate information concerning its food habits is available, except the results of an examination of 175 stomachs recently made in Scotland by Mr. John Gilmour. According to this examination, the food consists of 75 per cent insects, 20 per cent grain (mainly waste grain), and 5 per cent miscellaneous substances. Some useful insects were eaten, but the greater proportion were classed as injurious. The charge of destroying eggs of larks, and occasionally young nestlings, was not substantiated; as no egg shells were found in these stomachs. Mr. Gilmour calls attention to the rapid increase of starlings in Fifeshire, thousands now existing where fifty or sixty years ago they were considered rare; and mentions the serious damage sometimes done to shrubs and young plantations when occupied as roosting places, but concludes that on the whole the bird is beneficial and worthy of protection."

"Much has been said concerning the advantages of introducing the Starling into this country; but, in spite of the many arguments brought forward, the bird's character is not above suspicion, and its usefulness is still open to question. The fact seems to have been overlooked that in other countries the Starling has signally failed to fulfill the expectations concerning its usefulness. Certainly the experience of Australia and New Zealand offers little encouragement. It was introduced in New Zealand in 1867, and as early as 1870 was reported as 'becoming very numerous.' It seems to have increased very rapidly; and, in spite of its natural preference for insects, in its new home it has adopted a fruit diet to such an extent as to become a great pest. In South Australia it was reported to be common in certain localities in 1894, and measures for its extermination were considered. In Victoria, on the other hand, steps were taken in 1895 to promote its increase in fruit and grain growing districts, and this fact was used as an argument in its favor by persons who were endeavoring to introduce it into some of the other colonies. Western Australia has taken a firm stand on the question, and Mr. R. Helms, Biologist of the Bureau of Agriculture of that colony, who opposed the proposed importation, gives his reasons as follows: 'Had I been asked fifteen or twenty years ago what I had to say, I would probably have recommended their introduction. But not so now. My experience has taught me better. The birds were introduced more than fifteen years ago into New Zealand, and now, like the thrushes, they have become a pest to fruit growers. They have changed their habit, from being principally insectivorous having become omnivorous.'

"After due deliberation, the Government issued a proclamation on January 22, 1896, declaring the Starling a destructive bird, and absolutely prohibiting its importation into Western Australia. Still more recently it has been condemned in Tasmania, where it is charged with committing depredations on small fruits, cherries, and wheat. Its further distribution has been discouraged; and, when the question of introducing several species of birds was under discussion at an agricultural conference at Scottsdale on December 6, 1897, the Starling was promptly rejected." (Palmer, "Danger of Introducing Noxious Animals and Birds.")

Since the above was written Starlings have multiplied greatly, have spread to Rhode Island, western Massachusetts, New Jersey, and Pennsylvania, and are frequently found in flocks of thousands in fall, especially in the neighborhood of the salt marshes, where they assemble for the night. Besides the actual damage which they do to grain, etc., they seize all the hollow limbs in orchards, which the far more useful native birds have been accustomed to utilize for nesting; and more than once pairs of Starlings have been seen to attack and drive away even such a powerful bird as the Flicker from the cavity which it had just finished excavating. In our own State Mr. Wilbur F. Smith has reported instances of their damaging apples on the trees and of one having been seen flying from a tree with a Robin's egg in its bill. (*Bird-Lore,* X, 1908, p. 79.) Its enmity toward our other undesirable immigrant — the English Sparrow — is its chief claim to our consideration.

## BLACKBIRDS, ORIOLES, etc.

### *Icteridæ.*

The **Blackbirds**, from their habit of collecting in late summer in enormous flocks and descending upon the grain fields, have enjoyed since the first settlement of New England a bad reputation, which the experts in the Department of Agriculture inform us is better deserved than that of some other ostracized species. Dr. Merriam quotes ("Birds of Connecticut," p. 46), a law passed in Lynn, March 8, 1697, "That every householder in the town, should sometime before the fifteen day of May next, kill or cause to be killed, twelve blackbirds, . . . . and if any householder as aforesaid shall refuse or neglect to kill and bring in the heads of twelve blackbirds, as aforesaid, every such person shall pay three pence for every blackbird that is wanting, as aforesaid, for the use of the town." He quotes also from Peter Kalm's "Travels in North America": "Their chief and most agreeable food is maize. They come in great swarms in spring, soon after the maize is put under ground. They scratch up the grains of maize and eat them. As soon as the leaf comes out, they take hold of it with their bills, and pluck it up, together with the corn or grain; and thus they give a great deal of trouble to the country people, even so early in spring." Again in fall, "They assemble by thousands in the maize fields, and live at discretion. They are very bold; for, when they are disturbed, they only go and settle in another part of the field. In that manner, they always go from one end of the field to the other, and do not leave it till they are quite satisfied. They fly in incredible swarms in autumn; and it can hardly be conceived whence such immense numbers of them should come. When they rise in the air they darken the sky, and make it look quite black. . . . . As they are so destructive to maize, the odium of the inhabitants against them is carried so far that the laws of Pennsylvania and New Jersey have settled a premium of three pence a dozen for dead maize-thieves. In New England, the people are still greater enemies to them; for Dr. Franklin told me, in the spring of the year 1750, that, by means of the premiums which have been settled for killing them in New England, they have been so extirpated, that they are very rarely seen, and in a few places only. But as, in the summer of the year 1749, an immense quantity of worms appeared on the meadows, which devoured the grass, and did great damage, the people have abated their enmity against the maize-thieves; for they thought they had observed that those birds lived chiefly on these worms before the maize is ripe, and consequently extirpated them, or at least prevented their spreading too much. They seem therefore to be entitled, as it were, to a reward for their trouble."

Regarding these birds Professor Beal writes ("Birds that Injure Grain"): "Stomach investigation shows conclusively that birds do not subsist upon grain alone, even at times when it is possible to obtain it. Moreover, the greatest amount of grain is not eaten at harvest time, but during the winter months, when other food is scarce and waste kernels can be picked up in the fields. If any kind of grain is preferred by a certain species, we should expect the bird to subsist upon that almost exclusively when it can be obtained, that is, at harvest time. That this is not the case, is shown by the fact that many birds of the same species have been shot at the same time in a grain field, and, while some stomachs were full of grain, others were only partly filled, and still others were wholly filled with other food. So many cases of this kind have occurred that it seems practically certain that few birds willingly subsist exclusively upon any kind of grain for a considerable length of time. With many species this is in notable contrast to their marked fondness for the seeds of certain useless plants, upon which at some seasons they subsist almost entirely.

"If it be admitted that birds do not as a rule display an inordinate appetite for grain, the question naturally arises: What is the cause of the tremendous ravages they sometimes commit? Both stomach examination and field observation point to the same answer: Too many birds of the same or closely allied species are gathered together within a limited area.

"An attempt to exterminate these species would be not only ill-advised but hopeless. States have offered bounties for their destruction without perceptibly thinning their ranks. Is there, then, any remedy for evil? The writer is forced to confess that he has none to suggest, except in the case of crows and blackbirds that pull up sprouting corn. This can be prevented by thoroughly tarring the seed, which, if properly done, neither injures its vitality nor prevents the use of machinery in planting. There is, however, some hope for the future, though perhaps a distant one. While the advance of civilization has thus far not affected these birds or their haunts, the time must surely come when it will. Increased density of population will broaden the area of cultivation, and this in time must lead to the draining of the smaller marshes and ponds, thus turning over to agriculture much land that has heretofore been worse than waste, since it has served as a breeding ground for the birds that have destroyed the crops. With the breeding places more restricted, and an environment otherwise changed by increased population, the number of birds must surely decrease, and in time the proper equilibrium will be restored. In the meantime, it behooves the farmer to apply such remedies as the exigencies of the case suggest; and, where these gregarious species are overabundant, it might be well to exempt them from the general protective laws, in order that each landholder may be free to protect himself as best he can."

The **Bobolink** (*Dolichonyx oryzivorus*) must be studied from two standpoints to obtain a just view of its economic position. With us in the North it is not only the most joyous ornament of our fields, but of definite value to agriculture. During the time it is with us Professor Beal has determined, from the examination of 231 stomachs, that 57.1 per cent of its food consists of animal material, and 42.9 per cent vegetable. "Of the insect food, as determined by the examination, beetles constitute nearly 19 per cent. Predaceous species (Carabidæ), which are, broadly considered, useful insects, are represented only by a trace; snout-beetles, or weevils (Rhynchophora), amount to 8.9 per cent, and in May to 20.8 per cent; and the other beetles, of various families, and all of a more or less harmful character, make up the rest of the coleopterous food. Hymenoptera, represented by ants and some wasps, and by many parasitic species, form 7.6 per cent of the food, and were found mostly in May and July stomachs. The Bobolink eats more of these parasitic Hymenoptera than any other bird whose food habits have thus far been investigated, although it should be stated that examinations of flycatchers and other birds now in course of completion indicate that it will soon lose its position at the head of the list. Caterpillars are apparently a favorite food. They form 17.6 per cent of the May food, and rise to 28.1 per cent in June, after which they gradually decrease, averaging in the five months 13 per cent. Those eaten are mostly of the species known as cutworms, and include the well-known *Nephelodes violans.* Grasshoppers constitute 11.5 per cent of the food, and are eaten principally in June and July, when they amount to 23.2 and 25.8 per cent respectively. This is unusual. There seems to be a pretty general law that all birds, no matter what their food habits may be during the rest of the year, eat grasshoppers in August, just as the human race eats certain delicacies in their respective season. But in August, when with most birds the grasshopper season is at its height, the Bobolinks begin to drop their animal diet and eat vegetable food in preparation for the rice season in the South. Besides the insects already mentioned, a few bugs and flies are eaten, and also some spiders and myriapods." (Beal, "Food of Bobolinks, Blackbirds, and Grackles.")

Of the vegetable matter weed-seeds and rice constitute the largest portion.

In the South the picture is different. "In the last half of April it enters the United States just as the rice is sprouting in southern rice fields, and at once begins to pull up and feed upon the sprouted kernels." "It is estimated that the Bobolinks, with a little help from the Redwings, cause an annual loss of $2,000,000 to the rice growers of the South." "Capt. William Miles Hazzard of Hannandale, S. C., says: 'During the nights of August 21st, 22d, 23d, and 24th, millions of these birds make their appearance and settle in the rice fields. From August 21st to September 25th our every effort is to save the crop. Men, boys, and women are posted with guns and ammunition to every four or five acres, and shoot daily an average of about one-quarter of a lb. of gunpowder to the gun. This firing commences at first dawn of day, and is kept up until sunset. After all this expense and trouble our loss of rice per acre seldom falls under five bushels; and, if from any cause there is a check to the crop during its growth which prevents the grain from being hard but in a milky condition, the destruction of the rice is complete — not paying to cut and bring out of the field. We have tried every plan to keep these pests off our crop at less expense and manual labor than we now incur, and have been unsuccessful. Our present mode is expensive, imperfect, and thoroughly unsatisfactory, yet it is the best we can do.' Mr. R. Joseph Lowndes, of Annandale, S. C., in writing of the Bobolink and Redwing says: 'I think I am in bounds when I say that one-fourth, if not one-third of the [rice] crop of this river [the Santee] is destroyed by birds from the time the seed is put into the land till the crops are threshed out and put in the barns. I shoot out about 100 kegs of powder every September, with a fair quantity of shot, say 30 to 50 bags, and have killed as high as 150 dozen a day. In the bird season it takes every man and boy on the plantation to mind these birds. This work has to go on from daylight till dark in any and all weathers, and at great expense, for six weeks in the fall before the rice is ripe enough for the sickle, and then on till we can get it out of the fields. These birds, if not carefully minded, will utterly destroy a crop of rice in two or three days.' Mr. A. X. Lucas, of McClellanville, S. C., says: 'The annual depredations of the birds are in my opinion equal in this section to the value of the rent of the land — to say nothing of the expense of minding the birds.'" Professor Beal concludes, "In the North it does much good and practically no harm; in the South it becomes a veritable pest. To a person born and reared in New England and taught to regard this bird somewhat as the Hollanders regard the stork, it is an unwelcome duty to pronounce upon it a verdict of condemnation; but the facts force the belief that until some practical method shall be devised to prevent its ravages upon the rice crop there can be no other conclusion than that the good done by the Bobolink does not in any appreciable measure counterbalance the harm."

Were the feeding habits alone of the **Cowbird** (*Molothrus ater ater*) to be considered in determining its value, it would deserve protection, as Professor Beal finds that "(1) Twenty per cent of the Cowbirds' food consists of insects, which are either harmful or annoying. (2) Sixteen per cent is grain, the consumption of which may be considered a loss, though it is practically certain that half of this is waste. (3) More than 50 per cent consists of the seeds of noxious weeds, whose destruction is a positive benefit to the farmer. (4) Fruit is practically not eaten." But, when you remember that for every Cowbird that grows to maturity we lose probably all, or at least a part, of a family of some of our small birds — usually the Red-eyed Vireo, Yellow Warbler, or Oven-bird,— the balance changes. It may be impossible at present to prove that the birds we thus lose are of more value, but all the evidence points that way, and we believe the Cowbird should be killed with as little compunction as the English Sparrow, and its eggs destroyed at every opportunity.

Although the **Red-winged Blackbird** (*Agelaius phœniceus phœniceus*) feeds largely on grain during the months of harvest, its service in devouring weed seeds and harmful insects the rest of the year is so great as to turn the balance well in its favor. "The food of the year was found to consist of 73.4 per cent of vegetable matter and 26.6 per cent of animal. The animal food begins with 1.4 per cent in January, and gradually increases to 88.2 per cent in June, after which it regularly decreases to a fraction of 1 per cent in November. With the exception of a few snails and crustaceans, it consists entirely of insects and their allies (spiders and myriapods), so that, roughly speaking, insects constitute one-fourth of the year's food. They consist principally of beetles, grasshoppers, and caterpillars, with a few wasps, ants, flies, bugs, and dragon-flies.

"The beetles (Coleoptera) amount to a little more than 10 per cent of the food, and the greater part of them are harmful insects. They belong to several families, but only one group is eaten extensively enough to be greatly distinguished above the others. This is the suborder of snout-beetles, or weevils (Rhynchophora). These constitute 4.1 per cent of the year's food, but in June amount to 22.4 per cent of the food of the month. All the beetles of this group are injurious, some of them greatly so."

"Grasshoppers (Orthoptera) are eaten practically in every month of the year, though none were found in the 11 stomachs taken in January. They constitute 4.7 per cent of the whole food, and are exceeded by no other insects except beetles and caterpillars. The greatest number (amounting to 17 per cent) are eaten in August, the 'grasshopper month.' As all species of grasshoppers are injurious, their destruction must be counted to the credit of the bird."

"The vegetable food of the Redwings consists mainly of seeds of grasses and weeds, the different kinds of grain being merely larger or more important grasses. Some of these plants, like wild rice (*Zizania*), have no economic importance; but many others, such as the cultivated grains, are of value, and their destruction is a positive loss; while still others, like ragweed (*Ambrosia*), are noxious weeds, the destruction of which is a benefit to the farmer." Oats were found to constitute 6.3 per cent of the year's food; wheat 2.2 per cent; and corn, 4.6 per cent; oats are eaten chiefly in July and August; wheat, in July; and corn, in March, August, and September. Much of this grain is taken from the standing crop and must be counted against the bird. "Of the 1,083 stomachs examined, only 19 were filled with grain alone, while 217 were entirely filled with the seeds of weeds or useful plants."

"Weed seed is apparently the favorite food of the Redwings, since the total amount of grass and weeds is 54.6 per cent—more than half of the year's food, and more than four times the total grain consumption. These seeds are the principal article of diet of the birds in the Northern States in the early spring and late fall, and the stomachs received from the South during the winter are filled with them almost exclusively. They amount to more than 3 per cent in June, the month of minimum consumption, and constitute a very appreciable percentage even during the months when grain is most abundant. The great bulk consists of the four well-known genera of noxious weeds, *Chætochloa* (barn grass or foxtail), *Ambrosia* (ragweed), *Panicum* (panic-grass), and *Polygonum* (smartweed and knotweed). The others were found in from 1 to 64 stomachs each; and, while not all are as much of a nuisance to clean cultivation as the four named, none have any useful function in agriculture. Fruit forms so insignificant a proportion of the Redwing's food that it is hardly worth considering. Blackberries or raspberries were identified by their seed in 7 stomachs, but only a few were found in each, and the percentage is trifling. The other species taken also appear in few stomachs and in small quantities."

"In summing up the economic status of the Redwing, the principal point to attract attention is the small percentage of grain in the year's food — seemingly so much at variance with the complaints of the bird's destructive habits. Judged by the contents of its stomach alone, the Redwing is most decidedly a useful bird. The service rendered by the destruction of noxious insects and weed seeds far outweighs the damage due to its consumption of grain. The destruction that it sometimes causes must be attributed entirely to its too great abundance in some localities." (Beal, "Food of Bobolinks, Blackbirds, and Grackles.")

The **Rusty Blackbird** (*Euphagus carolinus*) only appears with us in any numbers in the fall after the grain is harvested, and its economic importance is not great. "The stomachs contained a larger proportion of animal matter (53 per cent) than those of any other species of American Blackbirds except the Bobolink. This is the more remarkable in view of the fact that none were taken in the two breeding months of June and July, when in all probability the food consists almost exclusively of animal matter. While the birds are decidedly terrestrial in their feeding habits, they do not eat many predaceous ground-beetles (Carabidæ), the total consumption of these insects amounting to only 1.7 per cent of the whole food. Scarabæids, the May-beetle family, form 2 per cent, and in April 11.7 per cent. Various other families of beetles aggregate 10.1 per cent, largely aquatic beetles and their larvæ, which, so far as known, do not have any great economic importance. A few of the destructive snout-beetles (Rhynchophora) are also included, as well as some chrysomelids and others.

"Caterpillars constitute 2.5 per cent, and do not form any very striking percentage at any time, except, perhaps, in May, when they amount to 11.7 per cent. Grasshoppers nearly equal beetles in the extent to which they are eaten, and exceed every other order of insects, although none appeared in the stomachs taken in January, March, May, and December, and in February but a trace. In August, as usual, they reach the maximum, 44.3 per cent, only a trifle higher, however, than the October record. The average for the year is 12 per cent."

"The vegetable food consists of grain, weed seed, and various miscellaneous substances, none of which amounts to any great percentage. The latter consists chiefly of a very small amount of fruit, a little mast, and a number of unidentifiable substances, probably picked up about water or in swamps. Of grain, corn is the favorite and amounts to 17.6 per cent of the year's food." "The vegetable food is of little consequence, as the birds show no decided predilection for any particular kind, but eat whatever is at hand when animal food cannot be obtained. Grain is not eaten to any great extent at harvest time, and the other items do not seem to have any special relation to the season in which they are eaten." (Beal, "Food of Bobolinks, Blackbirds, and Grackles.")

The **Crow Blackbirds** or **Purple** and **Bronzed Grackles** (*Quiscalus quiscula quiscula* and *æneus*) by their feeding habits present themselves here. "The food of the whole year, taking into account all the 2,346 stomachs, young and adult, comprised 30.3 per cent animal, and 69.7 per cent vegetable matter. The animal food was found to be composed of insects, spiders, myriapods, crayfish, earthworms, sowbugs, hair-snakes, snails, fish, tree-toads, salamanders (newts), lizards, snakes, birds' eggs, and mice.

"Insect food constitutes 27 per cent of the entire food for the year, and is the most interesting part of the birds' diet from an economic point of view."

"Analysis of the insect food presents many points of interest. Among the most important families of beetles are the scarabæids, of which the common June-bug or May-beetle and the rose-bugs are familiar examples. These insects are eaten, either as beetles or grubs, in every month except January and November; in May they constitute more than one-fifth, and in June one-seventh of the entire food. The habit Grackles have of following the plow to gather grubs is a matter of common observation, which has been fully confirmed by stomach examinations. Many stomachs were found literally crammed with grubs, and in many more, where other foods predominated, the hard jaws showed that grubs had formed a goodly portion of a previous meal."

"Next in importance to beetles as an article of blackbird diet are the grasshoppers. For convenience, grasshoppers, locusts (green grasshoppers), and crickets are considered in the same category, but of the three the true grasshoppers were by far the most numerous in the stomachs, and are eaten in every month except January. They constitute less than 1 per cent of the total February food, and the fact that they are found at all in this month indicates that the birds are keen hunters, for it would puzzle an entomologist to find grasshoppers in February in most of the northern states. It is probable that some of those eaten in this and the succeeding month are dead insects left over from the previous year."

"After August the grasshopper diet falls off, but even in November it still constitutes 9 per cent of the total for the month. The frequency with which these insects appear in the stomachs, the great numbers found in single stomachs (often more than 30), and the fact that they are fed largely to the young, all point to the conclusion that they are preferred as an article of food, and are eagerly sought at all times. The good that is done by their destruction can hardly be overestimated, particularly as many of the grasshoppers found in the stomachs were females filled with eggs."

"It cannot be doubted from the statements which have been made, that these birds do occasionally destroy the eggs of the robin, bluebird, chipping sparrow, small flycatchers, and other species, and more rarely the young of the robin. But stomach examination offers little corroborative evidence. Of 2,346 stomachs, only 37 contained any trace of birds' eggs, and 1 contained the bones of a young bird." (Beal, "Food of Bobolinks, Blackbirds, and Grackles.")

"Moreover, the examination of more than 2,000 of their stomachs shows that grain forms 45 per cent of the food of the year, and that corn alone constitutes 35 per cent. From this it might be expected that they would attract much attention from grain growers, and such is the case. Hundreds of communications have been received testifying to their destructiveness; yet many of these acknowledge the fact that blackbirds eat a large quantity of insects, especially during the breeding season, and that many insects are fed to the young. This last is also borne out by stomach examination. A review of the yearly diet shows that the greater part of the corn eaten is taken during the fall and winter months. That eaten in winter and early spring (March and April), except the small quantity taken from corn cribs, must be waste grain, or picked up in places where grain is left in the shock for a long time. No one will begrudge the birds the corn gathered from the hog lot or about the cattle crib; but, when they attack the ripening grain in September, it is a different story, and in cases where the birds are so abundant that they take a large part of the crop, it will be difficult to persuade the unfortunate farmer that they did enough good earlier in the season to pay for his loss. There can be little doubt that in many parts of the country these birds are too numerous for the farmer to realize the best results from their services." (Beal, "Birds that Injure Grain.")

The **Meadowlark** (*Sturnella magna magna*).—"In the 238 stomachs examined," Professor Beal says, "animal food (practically all insects) constituted 73 per cent of the contents, and vegetable matter 27 per cent. As would naturally be supposed, the insects were ground species, such as beetles, bugs, grasshoppers, and caterpillars, with a few flies, wasps, and spiders. A number of the stomachs were taken from birds that had been killed when the ground was covered with snow, but still they contained a large percentage of insects, showing the bird's skill in finding proper food under adverse circumstances.

"Of the various insects eaten, crickets and grasshoppers are the most important, constituting 29 per cent of the entire year's food and 69 per cent of the food in August. It is scarcely necessary to enlarge upon this point, but it can readily be seen, what an effect a number of these birds must have on a field of grass in the height of the grasshopper season.

"Of the 238 stomachs collected at all seasons of the year, 178, or more than two-thirds, contained remains of grasshoppers, and one was filled with fragments of 37 of these insects. This seems to show conclusively that grasshoppers are preferred and are eaten whenever they can be procured. The great number taken in August is especially noticeable. This is essentially the grasshopper month, i. e., the month when grasshoppers reach their maximum abundance; and the stomach examination has shown that a large number of birds resort to this diet in August, no matter what may be the food during the rest of the year.

"Next to grasshoppers, beetles make up the most important item of the Meadowlark's food, amounting to nearly 21 per cent, of which about one-third are predaceous ground beetles. The others are all harmful species, and, when it is considered that the bird feeds exclusively on the ground, it seems remarkable that so few useful ground beetles are eaten. Many of them have a disgusting odor, and possibly this may occasionally save them from destruction by birds, especially when other food is abundant. Caterpillars, too, form a very constant element, and in May constitute over 28 per cent of the whole food. May is the month when the dreaded cutworm begins its deadly career, and then the bird does some of its best work. Most of these caterpillars are ground feeders, and are overlooked by birds which habitually frequent trees; but the Meadowlark finds them and devours them by thousands. The remainder of the insect food is made up of a few ants, wasps, and spiders, with a few bugs, including some chinch bugs.

"The vegetable food consists of grain, weed, and other hard seeds. Grain in general amounts to 14, and weed and other seeds to 12 per cent. The grain, principally corn, is mostly eaten in winter and early spring, and must be therefore simply waste kernels; only a trifle is consumed in summer and autumn, when it is most plentiful. No trace of sprouting grain was discovered. Clover seed was found in only six stomachs, and but little in each. Seeds of weeds, principally ragweed, barn grass, and smartweed, are eaten from November to April, inclusive, but during the rest of the year are replaced by insects.

"Briefly stated, more than half of the Meadowlark's food consists of harmful insects; its vegetable food is composed either of noxious weeds or waste grain, and the remainder is made up of useful beetles or neutral insects and spiders. A strong point in the bird's favor is that, although naturally an insect eater, it is able to subsist on vegetable food, and consequently is not forced to migrate in cold weather any farther than is necessary to find ground free from snow. This explains why it remains for the most part in the United States during winter, and moves northward as soon as the snow disappears from its usual haunts.

"There is one danger to which the Meadowlark is exposed. As its flesh is highly esteemed, the bird is often shot for the table; but it is entitled to all possible protection, and to slaughter it for game is the least profitable way to utilize a valuable species." (Beal, "Some Common Birds in their Relation to Agriculture.")

The **Baltimore Oriole** (*Icterus galbula*) annoys the fruit-grower in August by sometimes puncturing grapes, and is also accused of occasional forays on the cherry trees, or the pea garden. But its services to the farmer and horticulturist far more than pay the toll it takes.

"Observation both in the field and laboratory shows that caterpillars constitute the largest item of its fare. In 113 stomachs they formed 34 per cent of the food, and are eaten in varying quantities during all the months in which the bird remains in this country, although the fewest are eaten in July, when a little fruit is also taken. The other insects consist of beetles, bugs, ants, wasps, grasshoppers, and some spiders. The beetles are principally click beetles, the larvæ of which are among the most destructive insects known; and the bugs include plant and bark lice, both very harmful, but so small and obscure as to be passed over unnoticed by most birds. Ants are eaten mostly in spring, grasshoppers in July and August, and wasps and spiders with considerable regularity throughout the season.

"Vegetable matter amounts to only a little more than 16 per cent of the food during the bird's stay in the United States, so that the possibility of the Oriole doing much damage to crops is very limited. The bird has been accused of eating peas to a considerable extent, but remains of peas were found in only two stomachs. One writer says that it damages grapes, but none were found. In fact a few blackberries and cherries comprised the only cultivated fruit detected in the stomachs, the remainder of the vegetable food being wild fruit and a few miscellaneous seeds." (Beal, "Some Common Birds in their Relation to Agriculture.")

The **Orchard Oriole** (*Icterus spurius*) is common only along our southern border, but is a valuable bird. "The food of the Orchard Oriole is almost exclusively insects. Of these it consumes a large number, and with them it also feeds its young. Most of these are of the kinds most obnoxious to the husbandman, preying upon the foliage, destroying the fruit, and otherwise injuring the tree; and their destroyers render an incalculable amount of benefit to the gardens they favor with their presence. At the same time they are entirely innocent of injury to crops of any description, and I cannot find that any accusations or expressions of suspicion have been raised against them. They seem to be, therefore, general favorites, and, whenever protected, evince their appreciation of this good will by their familiarity and numbers." (Baird, Brewer, and Ridgway, "North American Birds.")

## FINCHES, SPARROWS, GROSBEAKS, etc.

### *Fringillidæ.*

With this family we meet the small birds that throng our woods, fields, gardens, and hedges, and without whose presence it has been calculated agriculture could not continue, as cultivated crops would be either destroyed by insects or choked by a waste of weeds. "In nearly every case where the food habits of our birds have been carefully studied, do we find that the good done far exceeds the possible harm that might be inflicted by our birds. Allowing twenty-five insects per day as an average diet for each individual bird, and estimating that we have about one and one-half birds to the acre, or in round numbers 75,000,000 birds in Nebraska, there would be required 1,875,000,000 insects for each day's rations. Again, estimating the number of insects required to fill a bushel at 120,000, it would take 15,625 bushels of insects to feed our birds for a single day, or 937,500 bushels for 60 days, or 2,343,750 bushels for 150 days." (Bruner, Special Bulletin, University of Nebraska, No. 3.)

The Sparrows help chiefly in keeping down the weeds, as the largest part of their food during most of the year consists of the seeds of these pests to the cultivator. "Sparrows are well known and have figured frequently in ornithological literature, but the position they occupy in relation to agriculture has heretofore received only casual consideration. It is evident that a group of birds so abundant, so widely distributed, and in such constant association with farms and gardens must play an important part in rural economy, and that a thorough investigation of their food habits should be useful. The results of such an investigation are embodied in the present paper, and amply demonstrate the value of these birds to the agriculturist — a value greater than that of any other group of birds whose economic status has thus far been investigated. The native Sparrows contrast markedly in this respect with the introduced English Sparrow, the pernicious habits of which have formed the subject of a special report, and are briefly treated in this bulletin for purposes of comparison. This naturalized Sparrow is a pest wherever it is found, while the native Sparrows are well worthy of protection and encouragement.

"The great bulk of the food of Sparrows and other small passerine (or perching) birds consists of fruit, seeds, and insects. The fruit may be wild berries taken from shrubs or trees of no economic importance, with little economic result whether the bird eats much or little; or it may be cultivated fruit, in which case, of course, it is desirable to know the amount destroyed.

"The seed element is of particular interest only when it shows destruction of grain and weeds. Injury to grain or fruit by birds is usually the most prominent and often the only fact of economic ornithology possessed by the layman; yet comparatively few birds harm either of these crops, while many species render important service to agriculture by destroying weed seed. As has been aptly said, a weed is a plant out of place. Certain plants seem to have formed a habit of constantly getting out of place and installing themselves in cultivated ground, but whether actually among crops or in adjacent waste land, from which they can spread to cultivated soil, they are always a menace. In the garden they occupy the room allotted to useful plants, and appropriate their light, water, and food. Any check on these noxious interlopers, a million of which can spring up on a single acre, will not only lessen nature's chance of populating the soil with worse than useless species, but will enable the farmer to attain greater success with cultivated crops. The hoe and cultivator will do much to eradicate them, but some will always succeed in ripening a multitude of seeds to sprout the following season. Certain garden weeds produce an incredible number of seeds. A single plant of one of these species, as purslane, for instance, may mature as many as 100,000 seeds in a season, and these, if unchecked, would produce in a few years a number of weeds utterly beyond comprehension. The habits of some of the common weeds are considered in connection with the discussion of the value of birds as weed destroyers.

"The animal food of the smaller land birds consists of insects and spiders. The insects belong for the most part to the orders Lepidoptera (butterflies and moths), Orthoptera (grasshoppers, locusts, and crickets), Diptera (flies), Hemiptera (bugs), Coleoptera (beetles), and Hymenoptera (ants, bees, and wasps). Lepidoptera, Orthoptera, and Coleoptera furnish the bulk of the insect food of birds. The lepidopterous food is taken almost entirely in the larval condition, and comprises smooth caterpillars belonging largely to the family Noctuidæ, which includes cutworms, army worms, and their allies. The Orthoptera eaten are principally long- and short-horned grasshoppers (Locustidæ and Acrididæ). Coleoptera form a most important element of bird food, the families of this order most largely represented being the Scarabæidæ or scarabæid beetles, the Carabidæ or ground beetles, the Elateridæ or click beetles, the Chrysomelidæ or leaf beetles, and the Rhynchophora or weevils. Some of the scarabæids that are eaten are the clumsy brown May beetles and their allies which feed on growing plants; others comprise a group of beetles commonly known as dung beetles, because they subsist on the droppings of animals. Ground beetles are alert, active insects, carnivorous in food habits. Click beetles are narrow and hard-shelled; when disturbed, they curl up and 'play possum' until the danger appears to be past, when they spring into the air by spasmodically straightening out their bodies with a sharp clicking sound. Their larvæ, wireworms, are often very destructive to crops. The leaf beetles taken by birds are pests of little economic importance. Weevils constitute a destructive class of insect pests, and are extensively preyed on. Diptera furnish no significant part of the food of birds, though the slow-moving crane-flies (Tipulidæ) and midges (Chironomidæ) are at times snapped up, and some larval Diptera are occasionally eaten. The Hemiptera include both leaf-hoppers (Jassidæ), which derive their sustenance by probing plants with their sucking beaks, and true bugs, which are flat, bad-smelling insects. Some of the bugs feed like leaf-hoppers on the juices of plants, while others are predatory and subsist on succulent insects. The hymenopterous element of bird food is composed of ants, wasps, and a few small bees, the wasps including flower-fertilizing species and parasitic species of the families Ichneumonidæ, Braconidæ, and Scoliidæ.

"The value of a bird as an insect destroyer depends upon the value of the insects it consumes. Each insect eaten by birds must of necessity be injurious, beneficial, or neutral in its effect on crops, though it is not always easy to classify it properly. While present information is sufficient to fix the status of some with sufficient accuracy for all practical purposes, in the case of others more light is needed. The smaller dung-feeding scarabæid beetles appear to have little or no effect upon agriculture. The great majority of ants have habits which are apparently of little interest to the agriculturist; and although some (of the genus *Lasius*), and perhaps others, possess certain injurious traits, while a few may have traits that are beneficial, yet the effects in any event are of minor importance; so that ants as a whole may safely be classed as neutral. Spiders, which for purposes of convenience are here classed with insects, are carnivorous, but their prey seems to include about as many beneficial insects as pests. The damage done by weevils, grasshoppers, and smooth caterpillars is notorious. Cutworms and army worms often do an immense amount of harm, and grasshoppers frequently occur in such voracious hosts that they sweep away every vestige of green vegetation before them. On the other hand, carnivorous ground beetles (Carabidæ) kill multitudes of insect pests, and certain parasitic wasp-like hymenopterous insects of the families Braconidæ, Chalcididæ, and Ichneumonidæ destroy great numbers of caterpillars. One of these parasitic insects will deposit in the back of a caterpillar from 20 to 2,000 eggs, which soon hatch into grub-like larvæ that feed upon the fatty tissues and exhaust the caterpillar so that it is not able to transform into a perfect insect."

"On one of the Maryland farms visited in 1896, Tree Sparrows, Fox Sparrows, White-throated Sparrows, Song Sparrows, and Juncos fairly swarmed during the month of December in the briers of the ditches between the cornfields. They came into the open fields to feed on weed seed, and were most active where the smartweed formed a tangle on low ground. Later in the season the place was carefully examined. In a cornfield near a ditch the smartweed formed a thicket more than 3 feet high, and the ground beneath was literally black with seeds. Examination showed that these seeds had been cracked open and the meat removed. In a rectangular space of 18 square inches were found 1,130 half seeds and only 2 whole seeds. During the ensuing season no smartweed grew where the sparrows had caused this extensive destruction. Even as late as May 13 the birds were still feeding on the seeds of these and other weeds in the field. Sixteen sparrows were collected on that date, and 12 of these, mainly Song, Chipping, and Field Sparrows, proved to have been eating old weed seed. So thoroughly had the work been done that diligent search showed only half a dozen seeds in the field where they had been feeding. The birds had taken practically all that were not covered; in fact, the Song Sparrow and several others had scratched up much buried seed."

"It is hardly to be expected that such seed eaters as sparrows should destroy as great a quantity of insect pests as birds that are entirely insectivorous. When it is found that in the food of the native sparrows such pests average but 25 per cent, it is only what might be expected. Still this percentage, when compared with the percentage found in the cases of some birds, is no mean showing. The Red-winged Blackbird's is less than 20 per cent, the Catbird's but 16 per cent, the Cowbird's less than 20 per cent, and the Crow Blackbird's only 10 per cent.

"But as weed destroyers, the native sparrows are unrivaled. In a garden within two months they will sometimes destroy 90 per cent of such weeds as pigeon-grass and ragweed. After they have consumed most of these seeds they turn to those of other weeds, which furnish them with a bountiful supply of food all through the winter and even well into the spring. Weed seed forms more than half of their food for the entire year, and during the colder half of the year it constitutes about four-fifths of the food of many species."

"Part of the investigation on this farm was directed to the question of the dissemination of weed seed by sparrows. One hundred and fifty bird droppings were collected on each side of the brook, in the ragweed field and in the weedy garden above. Examination of these revealed but seven uninjured seeds, one of crab-grass and six of amaranth, certainly a very insignificant proportion of the number consumed. And it is not unlikely that many of those thus voided uninjured are afterwards taken a second time. Most of the dung consisted of the pulverized remains of seeds, among which the most conspicuous were small fragments of the akenes of ragweed." (Judd, " The Relation of Sparrows to Agriculture.")

We shall make no attempt to discuss the food of all the 34 members of this family that occur more or less regularly in our state, as the space required would be too great and nearly the same feeding habits characterize all, but confine ourselves to some of the more important or noticeable species.

The **Pine Grosbeak** (*Pinicola enucleator leucura*) occasionally visits us in flocks in winter. They " travel in small flocks, which spend much of their time in coniferous forests, feeding upon buds of pine and spruce; they also eat the buds and seeds of white ash, basswood, alder, birch, apple, pear, and poplar, as well as the berries of the red cedar and the high-bush cranberry. In winter they often subsist largely upon the pulp and seeds of frozen apples. In some instances they have been known to injure fruit orchards by feeding upon the buds, but this is a rare occurrence. Professor Aughey found that five Nebraska specimens taken during winter had eaten, along with various seeds, a large number of eggs of the Rocky Mountain locust." (Weed and Dearborn, " Birds in their Relation to Man.")

The **Purple Finch** (*Carpodacus purpureus purpureus*) has been seen, " ' feeding on the seeds of the poplar, buttonwood, juniper, cedar, and on those of many rank weeds that flourish in rich bottoms and along the margins of creeks. When the rainy season is very severe, they proceed to the South, as far at least as Georgia, returning North early in April. They now frequent the elm trees, feeding on the slender but sweet covering of the flowers; and as soon as the cherries put out their blossoms they feed almost exclusively upon the stamens of the flowers; afterwards the apple blossoms are attacked in the same manner; and their depredations on these continue until they disappear, which is usually about the tenth or middle of May.' Many later observers have seen the Purple Finch eating the tender portions, although little real damage seems to be done by it; and as a partial offset it is also known to devour aphides and various caterpillars." (Weed and Dearborn, "Birds in their Relation to Man.") This bird also often destroys the seeds of noxious plants, as the ragweed.

The **American and White-winged Crossbills** (*Loxia curvirostra minor* and *leucoptera*) feed chiefly on the seeds of pines, hemlocks, and spruces. None of the above species, however, have been shown to do any real harm, and none are usually common with us.

With the **English Sparrow** (*Passer domesticus domesticus*) the case is different. Thronging in our cities and crowding yearly farther into the country districts, multiplying with enormous rapidity and driving our small native birds before it, this once welcome foreigner has turned its warm reception into active dislike. But all attempts to exterminate it by bounty or combined effort have so far been failures, and the best that can be hoped for is to protect our native birds against its attacks and destroy it when possible. At first only an inhabitant of cities in this country, this sparrow readily adjusts itself to surroundings and climate, and the writer has seen it in flocks of hundreds far from towns in the interior of North Dakota. "The English Sparrow, or, more properly speaking, the house sparrow of Europe and Asia, was introduced into the United States about 1850, and has increased and spread until now it is one of the most abundant birds east of the Mississippi River. It does not, however, occur in the lower part of Florida and certain parts of Mississippi and Louisiana, nor in some portions of Maine, Minnesota, and North Dakota. West of the Mississippi River its range forms a tongue-like area extending to the base of the Rocky Mountains in Colorado, and includes Missouri, Kansas, Arkansas, Indian Territory, and parts of South Dakota, Texas, Oklahoma, and Nebraska. It is also found in isolated localities west of the Rocky Mountains, principally about the Great Salt Lake, San Francisco Bay, near Portland, Oregon, and on Puget Sound, Washington. In Canada it is established to a greater or lesser degree in all the eastern provinces. It has recently penetrated to Manitoba, but has not yet otherwise secured a foothold to the north and west of Ontario. Throughout its range it abounds chiefly in towns and villages, along roads, and about farms, and is not found in mountainous or forested districts.

"The relation of the bird to man was investigated by the Department of Agriculture, and the results were published in 1889. This investigation, which included extended field observation and the examination of more than 600 stomachs, showed the species to be a serious pest. Since the appearance of this publication 132 additional stomachs have been examined, and a special study has been made of the food of the young. For the latter purposes 50 birds from 3 days to 3 weeks old were collected during the last of June and the first of July, 1899, from a farming region in Virginia opposite Washington, D. C.

"The 82 stomachs of adults were collected throughout the year in rural localities in Maryland, Michigan, New York, Pennsylvania, Ohio, Indiana, and Kansas. Animal matter, practically all insects, constitutes 2 per cent of the food, and vegetable matter, almost entirely seeds, 98 per cent. Insects were taken chiefly during May and June, when they composed 10 and 8 per cent respectively of the month's food. Of the 98 per cent constituting the vegetable food, 7 per cent consisted of grass seed, largely of plants of the genera *Zizania* (wild rice), *Panicum,* and *Chætochloa,* and notably crab-grass and pigeon-grass, and 17 per cent of various weeds not belonging to the grass family. The grass and weed seeds taken are not noticeably different from those usually eaten by native sparrows. But what especially differentiates the vegetable food from that of all other sparrows is the large proportion of grain consumed, which formed 74 per cent of the entire food of the year and 90 per cent of that of the period from June to August.

"The examination of the contents of the stomachs of the 50 nestlings made an unfavorable showing for the species. It was found that, instead of being exclusively insectivorous, like the young of all the native sparrows so far as known, the young English Sparrows had taken 35 per cent vegetable food, 2 per cent being weed seed and 33 per cent grain. The animal food was made up entirely of insects and those were chiefly injurious. One per cent of the food consisted of bugs, 3 per cent of ants and other Hymenoptera, 4 per cent of Lepidoptera, 8 per cent of beetles, and 49 per cent of grasshoppers.

"Three-fourths of the beetles were weevils, and practically all the grasshoppers were the short-horned (Acrididæ), the greater part of which belonged to the species *Melanoplus atlanis* and *Melanoplus femur-rubrum.* The destruction of these harmful insects is of course a service to agriculture; but it must be remembered that all the food of the nestlings of other sparrows consists of insects just as injurious, while one-third of the food of English Sparrows is composed of grain.

"As an insect destroyer the English Sparrow does its best service by destroying grasshoppers, principally in feeding nestlings, nearly half of the food of which, as shown, was found to consist of grasshoppers of the genus *Melanoplus.* Other Orthoptera are eaten to a slight extent. It is a common sight along roads to see the birds pursuing and capturing the large dust-colored grasshopper (*Dissosteira carolina*) which shows yellow underwings when it flies. Long-horned grasshoppers (Locustidæ), small grasshoppers of the genus *Tettix,* and, in one instance at least, the mole cricket (*Gryllotalpa*) were included in the orthopterous food found in their stomachs. The species of Lepidoptera preyed on are important pests. Whenever there is an uprising of army worms, the English Sparrows feast on the abundant supply. They have been observed catching the moth also of the army worm. During spring and early summer, they remove many cutworms from lawns, and, to a certain extent, feed on hairless caterpillars on shade trees. Occasionally they destroy a few hairy caterpillars; they eat the fall webworm and tussock-moth caterpillars; and sometimes feed on the moths and egg clusters of the latter species; they are included by Forbush among birds seen to feed on the gypsy moth, and they have been observed by Weed preying on the moths of the forest tent caterpillar. But that they do not habitually eat hairy caterpillars and should not be expected to act as a potent check upon such insects, is evidenced by the fact that only two of nearly 700 stomachs examined contained hairy caterpillars."

"It appears, therefore, that there is little to be said in favor of the English Sparrow. Its insectivorous habits are creditable as far as they go, but they are insignificant because the diet is almost exclusively vegetable; and, while it is in the vegetable fare that the value of most sparrows consists, yet in the case of the English Sparrow the damage to grain far overbalances the benefit of weed seed destruction. Adding to this the injury it causes to buildings and statues in cities, there is no escape from the conclusion that the bird is a serious pest, the extermination of which would be an unmixed blessing." (Judd, "The Relation of Sparrows to Agriculture.")

As will be seen from these statistics, almost the entire food of this bird is vegetable food and this is taken chiefly from growing crops. It is known to inflict serious injury on grain, including rye, wheat, barley, rice, oats, and corn; green vegetables, including peas, cabbages, and tender shoots; fruits and berries, such as pears, apples, peaches, grapes, figs, cherries, and currants; and on buds, blossoms, and foliage of all sorts. Not content with this it attacks our native birds, preempts the breeding places of some, and enters the homes of Martins, Swallows, Bluebirds, and Wrens, destroys their eggs or young, and rears its own brood in their place. Professor Barrows gives a list of 75 species of our native birds which English Sparrows have been reported to molest, among which are 377 different records of their attacking the Bluebird, 182 on the Robin, 191 on different Wrens, 440 on Swallows and Martins, and 273 on other Sparrows. That its habits have not improved in recent years, an investigation made by Mr. Charles K. Reed in 1904 shows. Of over 100 postals and many letters received regarding this bird only four were in its favor. ("American Ornithology," Vol. 4, p. 130.)

Still another count in the grave indictment against this species has been proven by Mr. H. E. Ewing in *The Auk* for July, 1911; and he reaches the following conclusions: "The English Sparrow frequently harbors and is the host of one of our worst, if not the worst, of poultry pests, the chicken louse or chicken mite, *Dermanyssus gallinæ* Redi. Sparrows become repeatedly inoculated with these mites from the chicken roosts, because of their habit of lining their nests with poultry feathers, many of which have lice upon them, shaken off of the infested chickens when wallowing in the dust, etc. Sparrow nests, when built in the vicinity of chicken roosts, upon becoming deserted may leave hundreds or thousands of lice, to seek food and shelter elsewhere. These individuals being very active on their feet, and able to sustain themselves for several days away from a host, may travel distances and infest new chicken houses.

"The English Sparrow likewise harbors and is the host of perhaps the most important of all external parasites of our native song birds, and likewise of our tamed cage birds, the bird mite, *Dermanyssus avium* De Geer."

The English Sparrow multiplies so rapidly (having been known to raise six broods in a year) that our native birds could not compete with it were they equally pugnacious and capable like it of remaining in this region all the year. "It is a hardy, prolific, and aggressive bird, possessed of much intelligence and more than ordinary cunning. It is domestic and gregarious in habit, and takes advantage of the protection afforded by proximity to man, thus escaping nearly all the enemies which check the increase of our native birds. Moreover, for many years it was looked upon with favor, and both food and shelter were provided for it.

"Its fecundity is amazing; and, from the testimony submitted, it is evident that it is no unusual thing for a single pair, in the latitude of New York or further south, to rear twenty or thirty young in the course of a year. Assuming the annual product of a pair to be twenty-four young, of which half are females and half males, and assuming further, for the sake of computation, that all live, together with their offspring, it will be seen that in ten years the progeny of a single pair would be 275, 716, 983, 698." (Barrows, "English Sparrow in North America.")

With such a record, the only question left is what measures can best be taken against it. "In the city of Boston, during 1899, a crusade was inaugurated through the efforts of the American Society of Bird Restorers. From March 13 to April 5, six men were employed in the Common and Public Garden destroying the nests and eggs. Five thousand nesting holes were plugged up, 4,000 nests destroyed, and 1,000 eggs broken, but no birds were killed. It is claimed that nearly half of the sparrows which normally breed on the Common and Public Garden were driven away. In May only 250 to 300 pairs of sparrows were found, while the number of pairs counted in the parks before the sparrow war began amounted to 500.

"Much is always to be learned from an experiment of this kind, and other cities should profit by Boston's experience. There is reason to believe, however, that the present rapid supplanting of horse power by electricity will, by reducing the food supply of the birds, do more toward diminishing their numbers in the city parks than any plan for restricting their reproduction. The amount of expense that may profitably be incurred in combating the sparrow will depend on circumstances, as in the case of the house rat and mouse; but it should be borne in mind that the bounty system has proved to be only an extravagant failure." (Judd, "The Relation of Sparrows to Agriculture.")

But to effectually combat these pests more active measures must be taken. "Preliminary to the following destructive measures, sparrows should be baited until they are attached to the spot selected for their execution. Seeds, grain, or waste from the table, if supplied regularly, will soon establish a feeding place. If a general campaign is to be undertaken, enough such feeding places should be maintained to attract to them practically all the English Sparrows in the neighborhood. This can be easily done in winter when food is scarce. After thus baiting the sparrows they may be trapped, shot, or poisoned.

"Traps alone are inadequate to exterminate sparrows, but a reduction of numbers can be effected by using a shallow box not less than 4 feet square, open on one side and covered with woven wire on the other. One side of this trap rests on the ground, while the opposite side is supported by a stick 18 inches long. Near the upper end of this stick is attached a long cord, and between the top of it and the edge of the trap is placed a chip. By setting the trap over bait and pulling the cord from a sheltered place of observation when a flock of sparrows is beneath it, numbers of them may be caught. Instead of the box described above, by which the birds are taken alive, an old door or similar device may be employed as a deadfall. In either case the trap should be kept set and baited until the sparrows are not afraid to go under it. The best time for trapping is just after a snowstorm, when the birds have been fasting. Then, if the ground be cleared and chaff and grain be put under the trap, the birds will crowd in and enable the trapper to secure nearly all of the local flock. If any escape, they will spread the fear of traps, and before long very few of the birds can be induced to go into one.

" Sparrows are accustomed to feed in close flocks, and when thus assembled a large number can be killed by a charge of No. 10 shot. The best way is to scatter grain over long, narrow areas and shoot the sparrows at these baiting places. Where sparrows infest poultry yards, the bait may be placed on a horizontal board, supported at such an elevation that the birds can be shot without danger to the poultry.

" Since English Sparrows are a pest, and a reduction of their numbers is important on economic grounds, there would seem to be no reason why the birds, when trapped or shot, should not be utilized for food in this country, as they have been in the Old World for centuries. Their flesh is palatable and nutritious, and in city restaurants they are often served under the name of reedbirds.

" Where the use of poison is not prohibited by law, it may be effectively used to reduce the number of sparrows. Of the different poisons tested, the most satisfactory is strychnia sulphate. It is easily prepared and acts quickly. Wheat has proved to be a good bait, as well as an excellent vehicle for administering the poison. The grain should be regularly supplied at the baiting stations until the birds have become accustomed to resort to the place. A good time to put it out is early morning, as the birds are sure to be hungry for breakfast. The capacity of the sparrow's crop and stomach is about 30 kernels of wheat, varying according to the size of the kernels. In deciding the amount of poisoned wheat to put out at one time, it is well to estimate the number of sparrows frequenting a feeding place and to allow about 20 kernels for each sparrow.

" Although two kernels of wheat coated with the solution described below have been known to kill a sparrow, 6 or 7 kernels are required to insure fatal results. Only as much poison should be put out as is likely to be eaten in one day, as exposure to moisture reduces its virulence. Furthermore, sparrows that take less than a fatal quantity, or that become frightened by the death of comrades, will forsake a feeding place if poison is kept there constantly. It is better, therefore, to supply unpoisoned wheat after each poisoning until the birds have recovered confidence. An important advantage in having several feeding grounds is that they may be used in rotation, the sparrows forgetting their fear of one while the others in turn are receiving poison.

"A poison mixture that has proved very effective is prepared as follows: Put one-eighth ounce of strychnia sulphate into three-fourths of a gill of hot water, and boil until dissolved. Moisten 1½ teaspoonfuls of starch with a few drops of cold water, add it to the poison solution, and beat till the starch thickens. Pour the hot poisoned starch solution over 1 quart of wheat, and stir until every kernel is coated. Small-kerneled wheat sold as poultry food, if reasonably clean, is preferable to first-quality grain, being cheaper and more easily eaten by the sparrows. A 2-quart glass fruit jar is a good vessel to mix in, as it is easily shaken and allows the contents to be seen. If the coated wheat be spread thinly on a hard, flat surface, it will dry enough for use in a short time. It should be dried thoroughly if it is to be put into jars and kept for future use. Dishes employed in preparing poison may be safely cleansed by washing.

"The poison should be well scattered, so that many birds may be able to partake at the same time, since after a few are affected their actions excite the suspicion of their comrades. Usually a few sparrows get only enough strychnine to paralyze them for a few hours, after which they recover. It is important, therefore, to visit the feeding places two or three hours after distributing poison, to prevent such birds from escaping. It is well also to remove dead birds promptly to avoid exciting the suspicions of those that are unaffected. In northern latitudes the best time to put out poison is just after a snowstorm, when other food is covered. The feeding place should be cleared of snow and the poison laid early in the morning.

"Sparrows should be baited in secluded places, safe from interruptions, and where doves and poultry are not endangered. Roofs, back yards, and unused poultry runs are favorable situations. Proximity to low trees, grape arbors, and similar retreats, has the advantage that sparrows go to such places between meals, and many dead birds will be found there well away from the bait. If undisturbed, poisoned birds will usually be found within a few feet of where the bait was spread, death occurring in from three to twenty minutes. Where doves or poultry are likely to be poisoned, the sparrows, after being baited, may be induced to feed in small covered pens made of coarsely meshed wire netting and having the sides raised about an inch and a half above the ground. There is practically no danger that cats or other animals will die from eating sparrows that have been poisoned. Any wheat coated by the above process, which is overlooked by the birds, will become harmless after a few rains. Sparrows can be reduced locally to almost any desired extent by the methods outlined above, but it should not be forgotten that such reduction can be made permanent only by systematic and continued efforts." (N. Dearborn, "How to Destroy the English Sparrow.")

With this species our review of harmful and negative sparrows ceases, for almost all the remaining species are exceedingly useful.

The **American Goldfinch** (*Astragalinus tristis tristis*) "or wild canary, is as useful as it is beautiful, and as a weed destroyer has few equals. It confines its attention very largely to one family of plants, the Compositæ, and is especially fond of thistles, wild lettuce, wild sunflower, and ragweed. It is so often seen on thistles, both Canada and bull thistles, that it is commonly known as the thistle bird. Near Washington, D. C., a flock of a dozen birds was seen during the latter part of August feeding on sunflowers that had escaped from cultivation, and in the central and western states the Goldfinches do much good by eating the seeds of wild sunflowers and other closely related weeds. They have also been seen feeding upon wild lettuce (*Lactuca spicata*), and probably eat prickly lettuce (*Lactuca scariola*), which has proved the most rapidly spreading weed ever introduced into this country; but as yet no actual observations as to the latter food habit have been made. Stomachs collected in August were filled with seeds of Compositæ, mostly sunflowers (various species of *Helianthus*) and thistles (*Carduus lanceolatus* and other species.)

"At Burlington, Iowa, during July and August, Mr. Paul Bartsch found Goldfinches feeding exclusively upon the bull thistle (*Carduus lanceolatus*). He was able to approach within a few feet of several birds while thus engaged, and noticed that the seeds or akenes were bitten off and swallowed while the plumes or pappus floated away. When there was no wind, the pappus often failed to fly away, and clung to the birds, almost burying them with down. A dozen of the birds were killed, and their gizzards and gullets were found literally crammed with the thistle seed. At Sing Sing, N. Y., Goldfinches have been seen eating the seed of the Scotch thistle (*Onopordon acanthium*) and boneset (*Eupatorium perfoliatum*). Coneflowers (*Rudbeckia hirta*), prairie sunflowers (*Caillardia*), evening primroses, catnip, elephant's-foot (*Elephantopus* sp.), and mullein also form part of their food; and late in the season they turn their attention to ragweed, and consume great quantities of the seeds of this troublesome species. In winter and spring large flocks feed to some extent upon the seeds of conifers and catkin-bearing trees, such as the sycamore and birch. In destroying the seeds of the gray birch (*Betula populifolia*) on the edge of grass lands they do some good, for this tree has a habit of seeding adjacent pastures, which then grow up into a thicket of young saplings." (Judd, "Birds as Weed Destroyers.")

The **Pine Siskin** (*Spinus pinus*) and the **Redpoll** (*Acanthis linaria*) "feed largely upon seeds of conifers, sycamores, birches, and alders, but also descend to the ground to eat weed seed. In winter they feed upon sow thistles (*Sonchus oleraceus*), field asters (*Aster* sp.), and goldenrod (*Solidago* sp.). The Redpoll Linnet is known to destroy mullein seeds (*Verbascum thapsus*), and the Pine Siskin is often seen consuming quantities of seeds of chickweed (*Alsine media*), lamb's-quarters (*Chenopodium album*), and ragweed (*Ambrosia artemisiæfolia*)." (Judd, "Birds as Weed Destroyers.")

The **Snowflake** or **Snow Bunting** (*Plectrophenax nivalis nivalis*), coming in winter to our snow-covered fields, feeds on the seeds clinging to the weed stalks that stand above the drifts. "From the examination of the stomachs collected, it would appear that the Snowflake derives fully half its subsistence from two weeds — amaranth and ragweed; and that it does not to any great extent feed on the seeds of crab-grass, pigeon-grass, or other grasses, though it should be stated that McIlwraith reports it as eating the seeds of broom sedge (*Andropogon scoparius*). Only 1 per cent of the food contained in the 46 stomachs examined was grass seed. But, in addition to the fact that the number of stomachs examined was too small to permit final conclusions to be drawn, for other reasons this should not be taken as showing a distaste for grass seed. The taste for similar food, as shown by the partiality of the birds for grain, and the quantity of grass seed eaten by the closely allied, more southerly ranging Long-spurs, indicate that the abstinence of the Snowflake from this food is due to necessity and not choice. We must remember that the grass seed, which falls to the ground when ripe, instead of clinging to the stalk, as do many of the seeds of amaranth, lamb's-quarters, and ragweed, is probably buried under the snow during most of the time the Snowflakes are here. The amaranth is tall, and its seeds are particularly clinging, and after very heavy snowfalls it is probably the most available food supply the Snowflakes have. Its seeds form half the food found in the stomachs collected in February and March, some of which contained from 500 to 1,500 each. Such a wholesale destruction of the seeds of this rank weed as is thus indicated is not accomplished by any other bird whose food habits have thus far been investigated. With most species of seed-eating birds amaranth is by no means an important article of diet.

"On account of its good work as a weed destroyer and the apparent absence of any noticeably detrimental food habits, the Snowflake seems to deserve high commendation, and should receive careful protection. Feeding in latitudes that have been deserted by most other weed-destroying birds, these birds render a distinct and most effective service to the northern farmer." (Judd, "The Relation of Sparrows to Agriculture.")

The **Vesper Sparrow** (*Poœcetes gramineus gramineus*), a steadily decreasing summer resident of our hayfields, lives chiefly on different injurious insects while it is with us, the animal proportion of its food reaching 90 per cent in the height of summer. Beetles and grasshoppers are most sought after, and next to them come "cutworms, army worms, and other smooth caterpillars that infest upland grass lands." "Its value to the farmer is beyond question and should secure for it the fullest protection." (Judd, "The Relation of Sparrows to Agriculture.")

Regarding the **Savanna Sparrow** (*Passerculus sandwichensis savanna*), Dr. Judd finds from the examination of 119 stomachs that, "Their food contents consisted of 46 per cent of animal matter, insects and their allies, and 54 per cent of vegetable matter, practically all seeds. The Savanna, Ipswich, and Grasshopper Sparrows, and, to a slighter degree, all other members of the genus *Ammodramus,* are much more highly insectivorous than other sparrows. They take equal rank in this regard with such notable insect destroyers as the Catbird, Robin, and Bluebird. With the Savanna Sparrow the distribution of animal matter is as follows: Coleoptera, 15 per cent; Lepidoptera, 9 per cent; Orthoptera, 8 per cent; Hymenoptera, 5 per cent; Hemiptera, 2 per cent; Diptera and miscellaneous insects, 4 per cent; and spiders, with a few snails, 3 per cent.

"This sparrow appears to be the greatest eater of beetles of all the sparrow family. Beetles constitute the most important element of its animal food, and are eaten during every month in which stomachs were obtained, though, of course, in very small quantities during the winter months."

"The character of the vegetable food shows the Savanna Sparrow to be a great consumer of grass seeds. It is not harmful to grainfields, however, as the grain taken amounts to only about 1 per cent of the food, and this consists almost entirely of waste wheat and oats. During August, a month in which birds exhibit a great liking for a cereal diet, a number of Savanna Sparrows were collected from oat and barley fields, but their stomachs contained nothing but insects. Grass seed, largely pigeon-grass (*Chætochloa*) and panic-grass (*Panicum*), amounts to 31 per cent of the food. Other seeds, mainly such weed seeds as are taken by the Vesper Sparrow, make up practically all of the remaining 22 per cent of the vegetable matter, the only exception being a few blueberries found in one of the stomachs.

"It appears from this examination that the Savanna Sparrow is an exceedingly valuable bird. During the winter, when it is most granivorous, more than half of its food consists of weed seeds; and from May to August, when it is most insectivorous, beneficial insects form only 3 per cent of the food, while insects of the injurious class amount to 45 per cent." (Judd, "The Relation of Sparrows to Agriculture.")

About the **Grasshopper Sparrow** (*Ammodramus savannarum australis*) Dr. Judd writes, "The Grasshopper Sparrow received its name because of the character of its song, which closely resembles the stridulation of the long-horned grasshopper; but investigation of its food habits has shown that, by a curious coincidence, the name is fully as appropriate in consideration of its diet. Grasshoppers (Acrididæ and Locustidæ) form almost one-fourth (23 per cent) of the food of the eight months in which the 170 stomachs examined were collected, and 60 per cent of the food in June, in which the greatest quantity of these destructive insects is eaten. The genera *Xiphidium, Scudderia, Hippiscus,* and *Melanoplus* are best represented.

"Among the sparrows of the farm seven are preeminently grasshopper destroyers — the Dickcissel, and the Grasshopper, Lark, Vesper, Chipping, Song, and Field Sparrows; — and from May to August, inclusive, the insect-eating period, consume large quantities of these pests. The examination of stomachs collected during this period shows that grasshoppers form 41 per cent of the food of the Dickcissel, 37 per cent of that of the Grasshopper Sparrow, 31 per cent of that of the Lark Sparrow, 23 per cent of that of the Vesper Sparrow, 21 per cent of that of the Chipping Sparrow, 17 per cent of that of the Song Sparrow, and 13 per cent of that of the Field Sparrow."

"The vegetable food of the Grasshopper Sparrow is of little importance when compared with that of other species. No fruit was found excepting a few blueberries in one of the stomachs; and grain, chiefly waste, forms only 2 per cent of the food. Of the seeds, wood sorrel (*Oxalis*) composes 2 per cent of the food; ragweed, 5 per cent; such grasses as pigeon-grass, panic-grass, and a few others less freely eaten, 17 per cent; and various other plants — polygonums, purslane, rib-grass, and the sedges — 11 per cent. The entire weed seed element, including the seeds of such grasses as are troublesome on the farm (7 per cent of the total food), amounts to about one-fourth of the food.

"The Grasshopper Sparrow in particular, and the other species of the genus *Ammodramus* in general, feed much less on vegetable matter than most other sparrows. Insects form their staple diet, and of these, beetles, grasshoppers, and caterpillars are the most important. As a destroyer of insect pests the Grasshopper Sparrow is most efficient. It is not only superior to other members of the same genus, but is even more efficient than such valuable species as the Lark Sparrow, Vesper Sparrow, and Dickcissel; and, both its vegetable and animal food considered, it seems to be individually the most useful species of bird whose food habits have thus far been investigated. The injurious part of the food forms only 3 per cent of the whole, while the neutral amounts to 24 per cent, and the beneficial to 73 per cent." (Judd, "The Relation of Sparrows to Agriculture.")

The **Sharp-tailed** and **Seaside Sparrows** (*Passerherbulus caudacutus* and *maritimus maritimus*), inhabiting our salt marshes exclusively, have little effect on agriculture except as they destroy the insect enemies of the salt hay. "The examination of 81 stomachs of both species indicates that 2 per cent of the food consists of insects which probably exert a beneficial influence on the salt hay crop, 30 per cent consists of insects which are perhaps injurious to it, and 10 per cent consists of spiders, concerning whose relation to it there is much doubt. The remaining 58 per cent of the food is made up of approximately equal parts of insects and seeds of plants having little, if any, relation to the hay crop. The birds do not prey on the salt-marsh caterpillars, so destructive to the hay, and they destroy a considerable amount of the seed of the marsh grasses, which is probably an injurious effect. Thus, investigation shows that the two species are apparently of little economic importance." (Judd, "The Relation of Sparrows to Agriculture.")

Of the **White-throated Sparrow** (*Zonotrichia albicollis*), found in flocks along our hedge-rows in fall, Dr. Judd speaks as follows: "Two hundred and seventeen stomachs, collected during every month in the year except June, have been examined. Most of these stomachs were collected in New York and Pennsylvania, but a large number came from Iowa, Minnesota, Georgia, and Texas, and some from New Brunswick. The food for the year, as a whole, as indicated by stomach contents, consists of 19 per cent animal matter and 81 per cent vegetable matter. Of the vegetable food 3 per cent is grain, 50 per cent weed seed, and the remainder chiefly wild fruit.

"The insect food resembles that of many other species in general character, but some interesting differences appear when it is viewed in detail. Hymenoptera constitute 6 per cent of the year's food; Coleoptera, 5 per cent; Heteroptera and Diptera, taken together, 3 per cent; and Lepidoptera, 3 per cent; the customary quota of spiders, millipedes, and snails supplying the remaining 2 per cent of animal food."

"Some grass seed is consumed, principally seeds of such troublesome species as pigeon-grass, crab-grass and other panicums, and Johnson grass. This element forms about 5 per cent of the total food, and is taken chiefly during September, when it amounts to 24 per cent of the food of the month. A little amaranth and lamb's-quarters are eaten; and gromwell, chickweed, wood sorrel, sedge, violet, and sheep sorrel are all represented in the diet. But the principal weed seeds found in the stomachs are those of ragweed and different polygonums. As a destroyer of ragweed this sparrow seems to have no equal among finches, and the Song Sparrow is its rival as a consumer of polygonums. The two weeds form 25 per cent of the food for the year, of which ragweed furnishes 9 per cent, and the polgonums 16 per cent. During October ragweed alone constitutes 45 per cent of the month's food.

"The White-throated Sparrow may be regarded as a valuable bird on the farm; it has a good record as a weed destroyer, its fruit eating is largely confined to wild berries, and it does little damage to grainfields." (Judd, "The Relation of Sparrows to Agriculture.")

The **Tree Sparrow** (*Spizella monticola monticola*) remains with us all winter, gathering weed seed in the fields and the thickets along the brooks. "Five hundred and seventeen stomachs have been examined, collected at points ranging from Massachusetts to the District of Columbia, and westward as far as Iowa and Kansas, and during the period from October to May. As indicated by these examinations, the food of the Tree Sparrow during its stay in the United States is almost entirely made up of seeds, which amounts to 98 per cent of the total food contents of the stomachs examined. The bird shows an essential difference from its associates, however, in its large consumption of grass seed, fully half of its food consisting of this element, panicums, pigeon-grass, and allied grasses being apparently preferred." (Judd, "The Relation of Sparrows to Agriculture.")

"The Snowbird (*Junco hyemalis*) and Tree Sparrow (*Spizella monticola*) are perhaps the most numerous of all sparrows. The latter fairly swarms all over the northern states in winter, arriving from the north early in October and leaving in April. Examination of many stomachs shows that in winter the Tree

Sparrow feeds entirely upon seeds of weeds; and probably each bird consumes about one-fourth of an ounce a day. In an article contributed to the *New York Tribune* in 1881 the writer estimated the amount of weed seed annually destroyed by these birds in the State of Iowa. Upon the basis of one-fourth of an ounce of seed eaten daily by each bird, and supposing that the birds average ten to each square mile, and that they remain in their winter range two hundred days, we shall have a total of 1,750,000 pounds, or 875 tons, of weed seed consumed by this one species in a single season. Large as these figures may seem, they certainly fall far short of the reality. The estimate of ten birds to a square mile is much within the truth, for the Tree Sparrow is certainly more abundant than this in winter in Massachusetts, where the food supply is less than in the western states, and I have known places in Iowa where several thousand could be seen within the space of a few acres. This estimate, moreover, is for a single species, while, as a matter of fact, there are at least half a dozen birds (not all sparrows) that habitually feed on these seeds during winter." (Beal, "Some Common Birds in their Relation to Agriculture.")

In the summer the **Chipping** and **Field Sparrows** (*Spizella passerina passerina* and *Spizella pusilla*) take the place of the Tree Sparrows, and eat also large numbers of noxious insects. The former is known to eat the cankerworm, horse-tail moth, gypsy moth, army worm, forest tent caterpillar, cabbage worm, and pea louse.

Of the **Chipping Sparrow** Dr. Judd writes, "Two hundred and fifty stomachs have been examined, collected from March to November, and throughout the country both in the East and West, principally, however, from New England to Virginia, and from the states of Kansas, Iowa, Illinois, and California, the greater part of the western Chipping Sparrows coming from the last named state. More collections were made in the summer and early autumn than at any other season. Of the contents of these stomachs the total animal food, consisting of insects with an occasional spider, amounts to 38 per cent; the vegetable food to 62 per cent. Of the vegetable food, 4 per cent is grain, principally oats; 48 per cent grass seed; and 10 per cent other seeds, such as clover, ragweed, amaranth, wood sorrel, lamb's-quarters, purslane, chickweed, knotweed, and black bindweed. Twenty-six per cent of the grass seed is crab-grass and pigeon-grass, chiefly the former, the rest consisting of timothy, orchard grass, and other grasses. The seeds of crab-grass, whenever they can be obtained, form the most important part of the diet. During the last of August there were collected a dozen Chipping Sparrows that were feeding in a flock amid some crab-grass and other weeds which were getting the upper hand in a small garden, about an acre in extent; and it was found that the stomach of every one of the birds was crammed full of the seeds of crab-grass."

Regarding the **Field Sparrow** Dr. Judd says: "The laboratory investigation includes 175 stomachs collected during every month of the year, from 15 states and the District of Columbia, chiefly in New York, Massachusetts, and the District of Columbia in the East, and Kansas and Wyoming in the West. Of the total food they contained 41 per cent was animal matter and 59 per cent vegetable matter. Of the animal material, weevils form 2 per cent; leaf beetles, 2 per cent; ground, tiger, click, and May beetles, collectively, 9 per cent; caterpillars, 4 per cent; grasshoppers, 6 per cent; leaf-hoppers, true bugs, saw-flies, ants, flies, and spiders, taken together, 14 per cent; and parasitic wasps, 4 per cent. This last item is the principal point wherein the Field Sparrow differs in food habits from the Chipping Sparrow — a difference that is not to the advantage of the record of the species from an economic standpoint, since, as has been shown, these wasps are dangerous parasites of many caterpillars. Of the vegetable food 51 per cent consists of the seed of grasses, for the most part such species as crab-grass and other panicums, pigeon-grass, broom sedge, poverty grass (*Aristida*), and sheathed rush grass. Seeds of such weeds as chickweed, lamb's-quarters, gromwell, amaranth, purslane, spurge, wood sorrel, and knotweed amount to 4 per cent. The percentage of timothy is insignificant, but that of oats is comparatively large, as they constitute 4 per cent of the food." (Judd, "The Relation of Sparrows to Agriculture.")

The **Slate-colored Junco** (*Junco hyemalis hyemalis*), sometimes called the Black Snowbird, is another of our winter birds that industriously collect weed seed from field and garden. "The food habits of the Junco are such as commend it highly to the farmer. An examination has been made of 299 stomachs collected during every month in the year except May. They were secured chiefly along the Atlantic seaboard, but a fairly large number were obtained in the central part of the country and California.

"The food for the year, as a whole, as indicated by these stomachs, consists of animal matter 22 per cent and vegetable matter 78 per cent. The animal matter is distributed as follows: Orthoptera and Lepidoptera, each 2 per cent; Hymenoptera, 3 per cent; Coleoptera, 6 per cent; miscellaneous insects, largely Hemiptera, 7 per cent; and spiders, with a few snails and other invertebrates, 2 per cent."

"When the bird migrates to fertile districts and extends over the whole of the United States in autumn to remain until spring, it becomes a most important and useful bird. The animal food at this time, which is of the usual character, is too small to be important. The vegetable food, which constitutes 91 per cent of the diet, may be conveniently divided into three nearly equal parts; the first of which is largely timothy, broom sedge, sheathed rush grass, pigeon-grass, crab-grass and other panicums, paspalum, and a small quantity of grain; the second comprises ragweed and polygonums; and the third includes the seeds of various plants the majority of which are such weeds as amaranth, lamb's-quarters, chickweed, purslane, tick-trefoil, vetch, gromwell, wood sorrel, sedge, sheep sorrel, wild sunflower, and Russian thistle. The seeds of amaranth and lamb's-quarters are by far the most important in the diet. Few other sparrows eat as many of these seeds as the Junco, which feeds on them chiefly in March, when, doubtless, other and more palatable seeds are too scarce to be easily obtained.

"The effect of the Junco during its stay on agricultural land is that of an unmixed benefit, because the good done by its extensive consumption of weed seeds is not counterbalanced by any real harm; even the slight tendency toward eating grain is practically harmless, since most of the grain eaten consists of waste kernels." (Judd, "The Relation of Sparrows to Agriculture.")

The Song Sparrow (*Melospiza melodia melodia*) is in the summer the most abundant of our sparrows, and some remain with us throughout the year. "Its food, as indicated by the examination of 401 stomachs from 26 States and British Columbia, collected during every month of the year, consists of animal matter, insects with occasionally a spider or snail, 34 per cent; and vegetable matter, mostly seeds, 66 per cent."

"Of the vegetable portion (66 per cent) of the year's food, 3 per cent consists of ragweed, 5 per cent of grain, 16 per cent of polygonum and related seeds, 24 per cent of grass seed, and 18 per cent of miscellaneous seeds, such as those of wild sunflower, amaranth, lamb's-quarters, clover, gromwell, rib-grass, wild solanum, purslane, spurge, wood sorrel, dandelion, chickweed, dock, and sheep sorrel. The last two are seldom eaten by most other birds. More polygonum seed is taken by the Song Sparrow than by any other sparrow, largely because most polygonums grow in moist places where Song Sparrows are often very abundant. Several species of polygonums are weed pests on low ground, and much good is done by the systematic destruction of their seeds by the Song Sparrow during every month in the year. More than half the grass-seed food belongs to such troublesome species as crab-grass and pigeon-grass. The bird is so numerous that it must destroy large quantities of these weeds. The seeds of other grasses, such as timothy, paspalum, old-witch grass, barnyard grass, tall smooth panicum, spreading panicum, beard grass (*Andropogon*), orchard grass, sheathed rush grass, wild rye, wild rice, and others, form about 8 per cent of the food.

"The Song Sparrow, like the White-throated, White-crowned, and Fox Sparrows, manifests a taste for fruit, especially during July, when blackberries, raspberries, strawberries, blueberries, mulberries, and wild black cherries are eaten to the extent of nearly 8 per cent of the food. This diet is largely abandoned when the weed-seed harvest is mature, though the bird occasionally feeds with others on the ripening crop of wild fruits during late summer and autumn. It has been observed eating elderberries, wild grapes, pokeberries, bayberries, and berries of the woodbine; but, in spite of this taste and the bird's abundance among cultivated berry patches, it never, to any appreciable extent, does any damage to cultivated fruit.

"Insects amount to about one-third of the animal diet, and from May to August, inclusive, when they are eaten most freely, compose more than half the food."

"Taking the food habits of the Song Sparrow as a whole, it will be readily seen that this bird does much more good than harm and is worthy of protection and encouragement. Only 2 per cent of the food consists of useful insects, while 18 per cent is composed of injurious insects; and grain, largely waste, amounts to only 4 per cent, while the seeds of various species of weeds constitute 50 per cent." (Judd, "The Relation of Sparrows to Agriculture.")

The food of the **Lincoln's** and **Swamp Sparrows** (*Melospiza lincolni lincolni* and *georgiana*) resembles that of the Song Sparrow, as does that of the **White-crowned** (*Zonotrichia leucophrys leucophrys*) that of the White-throated Sparrow.

The food of the **Fox Sparrow** (*Passerella iliaca iliaca*), a common migrant, "as indicated by the examination of 127 stomachs, collected principally in the eastern states, and during every month excepting June, July, and August, consists of animal matter 14 per cent, and vegetable matter 86 per cent. The animal food is of little interest excepting in the month of April, when the bird begins eating largely of millepeds of the *Julus* group — 20 per cent of the food for the month consisting of these invertebrates,— and at the same time develops such a taste for ground beetles as to raise this item of its month's diet to 10 per cent. The quantity of these useful insects destroyed during the summer, when the bird is in its home in the far north, is probably much less.

"The vegetable food differs from that of most other sparrows, in that it contains less grass seed (only 1 per cent), less grain, and more fruit, ragweed, and polygonum. Half of the food consists of ragweed and polygonum, and more than a quarter of fruit. In its dependence on fruit the Fox Sparrow resembles the White-throated Sparrow. It does no direct damage to cultivated fruit, though it occasionally eats the buds of peach trees and pear trees. Bradford Torrey has observed it feeding on the fruit of burning bush (*Euonymus americana*). C. K. Averill, Bridgeport, Conn., reports that he has found it eating the berries of the red cedar (*Juniperus virginiana*), and James H. Gaut, of the Biological Survey, says that he has seen it feeding on pokeberries in November in Washington.

"But, although 28 per cent of the food contents of the stomachs examined consisted of the seeds of berries and of fruit skin, it is safe to say that barely a third of this percentage represents actual fruit destruction, and that the remaining two-thirds of the seeds were eaten after the pulp of the fruit had been removed by other agents." (Judd, "The Relation of Sparrows to Agriculture.")

In the stomach of a **Towhee** (*Pipilo erythrophthalmus erythrophthalmus*) were found "a locust, a mining beetle, a weevil, a ground beetle, a bug, a cricket, 6 ants, and the remains of broken seeds" (Judd, "Birds of a Maryland Farm"). "Its food consists of small seeds, grains, and fruits, as well as many insects; among the latter are included moths, beetles, ants, wasps and ichneumon-flies, cockroaches, grasshoppers, walking-sticks and their eggs, besides larvæ of many kinds. The young are fed upon insects similar to those eaten by the adults." (Weed and Dearborn, "Birds in their Relation to Man.")

Regarding the **Rose-breasted Grosbeak** (*Zamelodia ludoviciana*), Professor Beal says: "When the Colorado potato beetle first swept over the land, and naturalists and farmers were anxious to discover whether or not there were any enemies which would prey upon the pest, the Grosbeak was almost the only bird seen to eat the beetles. Further observation confirmed the fact, and there can be no reasonable doubt that where the bird is abundant it has contributed very much to the abatement of the pest which has been noted during the last decade. But this is not the only good which the bird does, for many other noxious insects besides the potato beetle are also eaten.

"The vegetable food of the Grosbeak consists of buds and blossoms of forest trees, and seeds, but the only damage of which it has been accused is the stealing of green peas. The writer has observed it eating peas, and has examined the stomachs of several that had been killed in the very act. The stomachs contained a few peas and enough potato beetles, old and young, as well as other harmful insects, to pay for all the peas the birds would be likely to eat in a whole season. The garden where this took place adjoined a small potato field which earlier in the season had been so badly infested with the beetles that the vines were completely riddled. The Grosbeaks visited the field every day, and finally brought their fledged young. The young birds stood in a row on the topmost rail of the fence, and were fed with the beetles which their parents gathered. When a careful inspection was made a few days later, not a beetle, old or young, could be found; the birds had swept them from the field and saved the potatoes.

"It is not easy to advise measures either for increasing the numbers of this bird or inducing it to take up its residence on the farm. Naturally it inhabits thin, open woods or groves, and the change from such places to orchards would be simple — in fact, has already been made in some parts of Pennsylvania and Ohio. In New England the bird is somewhat rare, and perhaps the best that can be done here or elsewhere is to see that it is thoroughly protected." (Beal, "Some Common Birds in their Relation to Agriculture.")

## TANAGERS.

### *Tangaridæ.*

The **Scarlet Tanager** (*Piranga erythromelas*) is known occasionally to take fruit, but this only incidentally. Those taken in May and August, Dr. Judd writes, have fed exclusively on insects. "Its food consists mostly of insects of which it takes a varied assortment. The stomachs of various specimens have been found to contain ants, ichneumon-flies, including what was thought to be the large *Thalessa lunator,* many caterpillars, crane-flies and other Diptera, curculios, click beetles, leaf chafers, and various other beetles, grasshoppers, a few bugs, an occasional dragon-fly or spider, and several harvest spiders. A single Nebraska specimen shot in the autumn of 1874 contained thirty-seven locusts. Three nestlings less than a week old, examined by Professor King, had eaten four caterpillars, one fly, one small grasshopper, one bug, besides undetermined fragments." (Weed and Dearborn, "Birds in their Relation to Man.")

## SWALLOWS.

### *Hirundinidæ.*

The Swallows, among which the **Purple Martin** (*Progne subis subis*) is included, are all strictly insectivorous and may be discussed together.

" Field observation will convince any ordinarily attentive person that the food of swallows must consist of the smaller insects captured in mid-air, or perhaps in some cases picked from the tops of tall grass or weeds. This observation is borne out by an examination of stomachs, which shows that the food consists of many small species of beetles which are much on the wing, many species of Diptera (mosquitoes and their allies), with large quantities of flying ants, and a few insects of similar kinds. Most of them are either injurious or annoying, and the numbers destroyed by swallows are not only beyond calculation, but almost beyond imagination.

" The **White-bellied Swallow** eats a considerable number of berries of the bayberry, or wax myrtle. During migrations and in winter it has a habit of roosting in these shrubs and it probably obtains the fruit at that time." (Beal, " Some Common Birds in their Relation to Agriculture.")

" Thirty swallows, collected between the middle of May and the middle of August, had eaten nothing but insects. Parasitic wasps and bees formed 2 per cent of their food (less than usual with aerial feeders), bugs 3 per cent, May-flies 8 per cent, beetles 13 per cent, white ants 21 per cent, ants 33 per cent, and miscellaneous insects, principally flies with a few bugs, 20 per cent. The forms selected were bees of the family Andrenidæ, and parasitic wasps of the families Scoliidæ, Ichneumonidæ, and Chalcididæ. The beetle food was interesting, for, besides click beetles, dung beetles (*Aphodius inquinatus, Hister, Atænius,* and *Onthophagus pennsylvanicus*), weevils of several species, and metallic wood-borers (*Agrilus*), it included the engraver beetles (among them *Tomicus cacographus*), which are destroyed by only a few other birds. The food of Swallows is peculiar in its lack of caterpillars and grasshoppers, which are so important to the subsistence of other birds. As with Flycatchers, the number of flies taken is generally overestimated. In the stomachs examined were found snipe-flies (*Leptidæ*), golden-green flesh-flies (*Lucilia cæsar*), and other Muscidæ, with an occasional banded-winged horsefly (*Chrysops*)." (Judd, " Birds of a Maryland Farm.") During a " locust year " in Nebraska 34 and 37 locusts have been taken from the stomachs of two **Barn Swallows** (*Hirundo erythrogastra*), and 229 from six **Cliff or Eave Swal-**

lows (*Petrochelidon lunifrons lunifrons*). The **Tree** or **White-bellied Swallows** (*Iridoprocne bicolor*) collect on our salt marshes in enormous flocks in late summer, and as they skim back and forth over the shallow pools do what is possible to lessen the plague of mosquitoes. With them associate smaller numbers of **Bank Swallows** (*Riparia riparia*), and join in the hunt for flying insects of all kinds. Messrs. Weed and Dearborn state that ten **Purple Martins** (*Progne subis subis*) examined by Professor Aughey in Kansas had eaten 265 locusts, besides 161 other insects. This bird is said to kill a few honey-bees, but this must be forgiven it for its good qualities.

## WAXWINGS.

### *Bombycillidæ.*

The **Cedar Waxwing** (*Bombycilla cedrorum*) is a capital fly-catcher, darting from a twig and seizing insects in the air with the skill of a Kingbird. The stomachs of seven shot in an orchard infested with cankerworms were found by Professor Forbes to contain over 100 worms apiece, and they are said also to feed freely on the elm-tree beetle. "Its proverbial fondness for cherries has given rise to its popular name, and much complaint has been made on account of the fruit eaten. Observation has shown, however, that its depredations are confined to trees on which the fruit ripens earliest, while later varieties are comparatively untouched. This is probably owing to the fact that, when wild fruits ripen, they are preferred to cherries, and really constitute the bulk of the Cedar Bird's diet.

"In 152 stomachs examined animal matter formed only 13, and vegetable 87 per cent, showing that the bird is not wholly a fruit eater. With the exception of a few snails, all the animal food consisted of insects, mainly beetles, and all but one more or less noxious, the famous elm leaf beetle being among the number. Bark or scale lice were found in several stomachs, while the remainder of the animal food was made up of grasshoppers, bugs, and the like. Three nestlings were found to have been fed almost entirely on insects.

"Of the 87 per cent of vegetable food, 74 consisted entirely of wild fruit or seeds, and 13 of cultivated fruit, but a large part of the latter was made up of blackberries and raspberries, and it is very doubtful whether they represented cultivated varieties. Cherry stealing is the chief complaint against this bird; but of the 152 stomachs only 9, all taken in June and July, contained any remains of cultivated cherries, and these aggregate but 5 per cent of the year's food. As 41 stomachs were collected in those months, it is evident that the birds do not live to any great extent on cultivated cherries.

"Although the cherry bird is not a great insect destroyer, it does some good work in this way, since it probably rears its young mostly upon insect food. On the other hand, it does not devour nearly as much cultivated fruit as has been asserted, and most if not all of the damage can be prevented. The bird should therefore be considered a useful species, and as such should be accorded all possible protection." (Beal, "Some Common Birds in their Relation to Agriculture.")

## SHRIKES.

### *Laniidæ.*

The only Shrike at all common with us is the **Northern Shrike or Butcher-bird** (*Lanius borealis*), and that occurs only in winter. The **Migrant Shrike** (*Lanius ludovicianus migrans*), a variety of the **Loggerhead**, is known only as a rather rare migrant. The name Butcher-bird comes from the habit these birds have of impaling their prey — mice, grasshoppers, or small birds — on a thorn or a sharp twig of a tree. "The food habits of the Shrikes, so far as determined from the examination of 155 stomachs, collected during every month of the year, from Saskatchewan to Florida and from the Atlantic to the Pacific, are very similar to those of the Sparrow Hawk; that is to say, the food consists of mice, small birds, and insects, the latter mainly grasshoppers. Both birds are much less insectivorous in cold than in warm weather — the oncoming of winter and consequent increasing scarcity of insects necessitating a change in food.

"In discussing the insectivorous habits of the Shrike, it is hardly necessary to state that the destruction of grasshoppers is a great service to the farmer. The Shrike also devours a large number of beetles, and often eats caterpillars, wasps, and spiders. Since it takes practically no vegetable food, it cannot injure crops, unless indirectly, by killing birds and insects that prey upon insect pests. The birds selected, however, are for the most part seed eaters, and consequently less valuable than the insectivorous kinds; and, if it be granted that the harm done by destruction of one of these birds is counterbalanced by the killing of one mouse, then it follows that the harm done by the Shrike in killing birds is completely offset. Furthermore, the attacks of the Shrike are often directed against the English Sparrow, now so obnoxious in many parts of the United States. Concerning the insect food, it may be safely stated that the percentage of noxious grasshoppers is four times as great as that of the useful ground beetles.

"In considering the relation of the Shrikes to agriculture, it must be remembered that one inhabits a fertile country where cultivation yields heavy crops, while the other lives in a northern region where agriculture amounts to very little. Therefore, the good or harm done by the Northern Butcher-bird must be mainly accomplished when it migrates south into the United States. From the present limited investigation, it appears that the beneficial qualities of both Shrikes outweigh the injurious. Furthermore, it is probable that when it is possible to study the summer food habits of the Butcher-bird, this species, like its southern relative, the Loggerhead, will be found to be a destroyer of quantities of grasshoppers and other noxious insects." (Judd, "The Food of Shrikes.")

The Northern Shrike during its winter sojourn "renders a threefold service by killing grasshoppers, English Sparrows, and mice. The birds and mice together amount to 60 per cent, and insects to 40 per cent, of the food from October to April. Grasshoppers constitute one-fourth of the food, and are equal to twice the combined amounts of beetles and caterpillars.

"Apparently no mineral or vegetable matter is intentionally swallowed. Indeed, its exclusively animal diet makes it, practically, a bird of prey, and therefore we must consider what animals it destroys.

"The Chippewa Indians call this Shrike 'big cannibal bird,' and several instances of cannibalism are recorded. In one case a hungry Butcher-bird pounced upon and carried off his companion, which had been shot and laid on the top of a log cabin.

The Butcher-bird, when impelled by extreme hunger, becomes very bold, and has been known to enter a room and decapitate a caged canary.

"In the stomachs of the 67 Butcher-birds examined, 28 species of seed-eating birds were found. Of these 3 were Tree Sparrows, 5 Juncos, and 7 English Sparrows; the others could not be named with certainty. The Tree Sparrows and Juncos were found in Shrikes that had been taken in rural districts. On the other hand, English Sparrows were found only in stomachs of birds that had been collected in cities.

"In speaking of the enemies of the English Sparrow, Professor W. B. Barrows says:

"'Probably the most useful bird in this respect is the Northern Shrike (*Lanius borealis*), which visits most of our northern cities in winter and feeds freely on the sparrow. At one time this Shrike became so abundant on the Common and public parks in Boston that it threatened to destroy all the sparrows, but the short-sighted authorities kept a man busy shooting the Shrikes, until several dozen had been killed, and the useless sparrows were considered safe.'

"It is to be hoped that in other cities this enemy of the sparrow will be protected instead of persecuted. If there were six Butcher-birds in each of 20 New England cities, and each Butcher-bird killed one sparrow a day for the three winter months, the result would be a removal of 10,800 sparrows. Since two sparrows could raise under favorable conditions four broods of five each, the increase would be tenfold, so that those destroyed by the Butcher-birds, if allowed to live, would have amounted at the end of the first year to 118,800, and at the end of the second year to 1,306,800 individuals."

"Mice were found in one-third of the stomachs examined, constituting one-fourth of the food, and were eaten most frequently in March. Of these mice 15 were identified as follows: 1 white-footed mouse (*Peromyscus*), 1 harvest mouse (*Reithrodontomys*), and 8 meadow mice (*Microtus*)."

"Active insects are much more liable than sluggish ones to fall victims to the Butcher-bird, because objects which at rest cannot be discriminated are instantly seen when moving. Thus it happens that flying grasshoppers and running beetles form a large proportion of the food of this bird. Grasshoppers and crickets (Orthoptera), which are eaten during every month from October to April, form 24 per cent of the total volume of food, and for October and November together these insect pests form more than half of the food." (Judd, "The Food of Shrikes.")

Dr. Judd gives a list of 17 species of our small birds that this Shrike has been known to kill.

Of the stomachs of 9 Northern Shrikes taken in Connecticut between November 6th and March 1st, examined by the author, 1 contained a mammal; 4, birds; 4, insects, chiefly grasshoppers; and 1, feathers and seeds.

By the **Loggerhead Shrike**, of which our **Migrant Shrike** is a subspecies, 13 species of birds have been known to be killed; but the studies of the Biological Survey show that birds constitute a smaller proportion of its food than they do of its larger relative, its diet being chiefly insects. Of the stomachs of 5 Connecticut specimens of the Migrant Shrike taken between Oct. 2 and Feb. 15, examined by the author, 1 contained a bird; 4, grasshoppers; and 1, beetles.

## VIREOS.

### *Vireonidæ.*

Insects in form of egg, larva, pupa, or adult are the proper food of the **Vireos**, and are sought for industriously by them over the branches and under the leaves of our trees during the months they are with us. "Twenty-five Vireos were collected, including 2 Warbling Vireos (*Vireo gilvus*), 10 White-eyed Vireos (*Vireo noveboracensis*), and 13 Red-eyed Vireos (*Vireo olivaceus*). Ninety-one per cent of their food consisted of insects, and 9 per cent of fruit (mulberries and sassafras). Parasitic wasps formed 2 per cent, ants and other Hymenoptera 6 per cent, May-flies 4 per cent, caterpillars 15 per cent, bugs 17 per cent, beetles 28 per cent, miscellaneous insects 8 per cent, and spiders 11 per cent. The Hymenoptera, other than ants, comprised jointworm flies, sawfly larvæ, ichneumon flies, and bees of the genus *Halictus*."

"The bugs were stink-bugs (*Podisus*), leaf-hoppers (Jassidæ), and scale insects (*Kermes*). The Yellow-throated Vireo (*Vireo flavifrons*) has been noted at Marshall Hall by Mr. William

Palmer. All the Vireos are very useful protectors of forest and fruit trees." (Judd, "Birds of a Maryland Farm.")

Insects of many kinds are given to the young and occasionally raspberries and blackberries. They are among our most useful birds.

**Red-eyed Vireo** (*Vireosylva olivacea*).—"From the stomachs of eighteen of this species were taken fifteen caterpillars; five other larvæ; eight beetles — among them five weevils, one long-horn and one darkling beetle; seventy heteropterous insects — among them sixty-seven chinch-bugs; sixteen winged ants; one ichneumon; five dragon-flies; two dipterous insects — one of them *Tabanus atratus;* and seven dogwood berries. Of thirty-six other specimens examined, fifteen had eaten caterpillars; two, other larvæ; nine, beetles — among them two *Coccinella mali;* three, grasshoppers; two, ants; two, moths; four, insects none of which were identified; and seven, fruit or seeds, among which were raspberries, dogwood berries, berries of prickly ash, and sheep berries."

**Yellow-throated Vireo** (*Lanivireo flavifrons*).—"Of twenty-one specimens examined, seven had eaten caterpillars — among them geometers; seven, beetles — among them weevils and a buprestis; three, grasshoppers; two, moths; two, heteropterous insects — among them leaf-hoppers; three, dipterous insects."

**Warbling Vireo** (*Vireosylva gilvus*).—"Of sixteen specimens examined, eight had eaten thirty-four caterpillars; two, five beetles, among which were a ladybird (*Coccinella sex-notata*), and a *Dibrotica duodecim-punctata*: three, three heteropterous insects; two, two crane-flies; one, grasshopper; two, twenty-eight insects' eggs; and one, dogwood berries." (King, in Chapman, "The Economic Value of Birds to the State.")

The **White-eyed Vireo** (*Vireo griseus griseus*) is a common summer resident of the tangled thickets of our southern border. "The food of this species in early summer is almost exclusively small insects, which it gleans with great assiduity. In eastern Massachusetts, like all its kindred, it feeds eagerly upon the young larvæ of the destructive cankerworm, and doubtless, in the wilder portions of the country, is of considerable service in restricting the increase of this scourge." (Baird, Brewer, and Ridgway, "North American Birds.")

## WOOD WARBLERS.

### *Mniotiltidæ.*

Next to the Sparrows in point of numbers, the **Warblers** fill the same good office against insects that the former do against weeds. "The Warblers have we always with us — all, in their own good time; they come out of the South, pass on, return, and are away again, their appearance and withdrawal scarcely less than a mystery; many stay with us all summer long, and some brave the winters in our midst. Some of these slight creatures, guided by unerring instinct, travel true to the meridian in the hours of darkness, slipping past like a 'thief in the night,' stopping at daybreak from their lofty flights to rest and recruit for the next stage of the journey. Others pass more leisurely from tree to tree, in a ceaseless tide of migration, gleaning as they go; the hardier males, in full song and plumage, lead the way for the weaker females and the yearlings. With tireless industry do the Warblers befriend the human race; their unconscious zeal plays due part in the nice adjustment of nature's forces, helping to bring about the balance of vegetable and insect life without which agriculture would be in vain. They visit the orchard when the apple and pear, the peach, plum, and cherry, are in bloom, seeming to revel carelessly amid the sweet-scented and delicately-tinted blossoms, but never faltering in their good work. They peer into the crevices of the bark, scrutinize each leaf, and explore the very heart of the buds, to detect, drag forth, and destroy those tiny creatures, singly insignificant, collectively a scourge, which prey upon the hopes of the fruit grower, and which, if undisturbed, would bring his care to nought. Some Warblers flit incessantly in the terminal foliage of the tallest trees; others hug close to the scored trunks and gnarled boughs of the forest kings; some peep from the thicket, the coppice, the impenetrable mantle of shrubbery that decks tiny watercourses, playing at hide-and-seek with all comers; others more humble still descend to the ground, where they glide with pretty mincing steps and affected turning of the head this way and that, their delicate flesh-tinted feet just stirring the layer of withered leaves with which a past season carpeted the ground. We may seek warblers everywhere in their season; we shall find them a continual surprise; all mood and circumstance is theirs." (Coues, "Birds of the Colorado Valley.")

"Of the food of the 53 specimens collected, 96 per cent consisted of insects, and 4 per cent of fruit. The insect food was distributed as follows: beetles, 21 per cent; ants, wasps, and bees, 18 per cent; May-flies, 16 per cent; caterpillars, 14 per cent; bugs (leaf-hoppers, scale insects, and true bugs), 6 per cent; miscellaneous insects, including flies, a few grasshoppers, and others, 8 per cent; spiders, 11 per cent; and miscellaneous invertebrates, principally snails, 2 per cent. Of the 21 per cent of beetles, 3 per cent were useful forms, 5 per cent neutral, and 13 per cent injurious." (Judd, "Birds of a Maryland Farm.")

Of the individual species it is necessary to say little, as their food is practically the same — insects almost exclusively,— although the **Myrtle Warbler** (*Dendroica coronata*) feeds on bayberries frequently in winter. The **Tennessee Warbler** (*Vermivora peregrina*) in some parts of the country pierces grapes, but with us it is hardly more than a straggler. A Nebraskan **Black and White Warbler** (*Mniotilta varia*) has been known to eat 41 locusts and 21 other insects at a meal; while from the stomachs of two Wisconsin birds were taken 21 caterpillars. Two **Myrtle Warblers** were found by Professor King to have eaten 21 caterpillars, mostly measuring-worms; five, to have eaten 14 two-winged flies, among which were three crane-flies; and 15, to have eaten 48 beetles. "Two-thirds of the food of five Illinois **Yellow Warblers** (*Dendroica æstiva æstiva*) consisted of cankerworms, and most of the remainder was an injurious beetle." The **Maryland Yellowthroat** (*Geothlypis trichas trichas*) "especially frequents the shrubbery about standing or running water, where it can be found throughout the summer busily searching for insect food. It often visits orchards, where cankerworms and other caterpillars are greedily devoured, these forming in three cases on record four-fifths of its food. The little case-bearing caterpillars of the genus *Coleophora* and its allies are often eaten, while butterflies, moths, two-winged flies, beetles, grasshoppers, leaf-hoppers, bugs, dragon-flies, Hymenoptera, and insects' eggs are all included on the bill of fare. The young are sometimes fed with small grasshoppers, and these insects are a favorite item of food with the adult birds." (Weed and Dearborn, "Birds in their Relation to Man.") Seven Nebraskan **American Redstarts**

(*Setophaga ruticilla*) had eaten 161 small locusts and 177 other insects; and 11 Wisconsin birds, 14 small beetles, 4 very small moths, 4 small hymenopterous insects, and a large number of dipterous insects. This Warbler catches insects on the wing as readily as a flycatcher. Such instances of the feeding habits of our Warblers might be multiplied indefinitely with each species of the family, but these are more than sufficient to show how indispensable these birds are to the state.

## PIPITS.

### *Motacillidæ.*

The **American Pipit or Titlark** (*Anthus rubescens*) might in many ways be called the Warbler of the fields, as its food is chiefly insects. "No extended study of the food habits of this species appears to have been made. It is asserted, however, by various authors to feed on beetles, spiders, seeds in the fields, and along shore on minute shells, shrimps, etc." (Chapman, "The Economic Value of Birds to the State.")

## MOCKINGBIRDS and THRASHERS.

### *Mimidæ.*

The **Catbird** (*Dumetella carolinensis*) "always attracts attention, and the intruder upon its haunts soon understands that he is not welcome. There is no mistaking the meaning of the sneering voice with which he is saluted, and there is little doubt that this gave rise to the popular prejudice against the bird; but the feeling has been increased by the fact that the species is sometimes a serious annoyance to fruit growers. All such reports, however, seem to come from the prairie country of the West. In New England, according to the writer's experience, the Catbird is seldom seen about gardens or orchards; the reason may possibly be found in the fact that on the prairies fruit-bearing shrubs which afford so large a part of this bird's food are conspicuously absent. With the settlement of this region comes an extensive planting of orchards, vineyards, and small fruit gardens, which furnish shelter and nesting sites for the Catbird, as well as for other species, with a consequent large increase in their numbers, but without providing the native fruits upon which they have been accustomed to feed. Under these circumstances, what is more natural than for the birds to turn to cultivated fruits for their supplies? The remedy is obvious; cultivated fruits can be protected by the simple expedient of planting wild species or others which are preferred by the birds. Some experiments with Catbirds in captivity showed that the Russian mulberry was preferred to any cultivated fruit that could be offered.

"The stomachs of 213 Catbirds were examined, and found to contain 44 per cent of animal (insect), and 56 per cent of vegetable food. Ants, beetles, caterpillars, and grasshoppers constitute three-fourths of the animal food, the remainder being made up of bugs, miscellaneous insects, and spiders. One-third of the vegetable food consists of cultivated fruits, or those which may be cultivated, such as strawberries, raspberries, and blackberries; but, while we debit the bird with the whole of this, it is probable — and in the eastern and well wooded part of the country almost certain — that a large part was obtained from wild vines. The rest of the vegetable matter is mostly wild fruit, such as cherries, dogwood, sour gum, elderberries, greenbrier, spice berries, black alder, sumac, and poison ivy.

"Although the Catbird sometimes does considerable harm by destroying small fruit, the bird cannot be considered injurious. On the contrary, in most parts of the country it does far more good than harm, and the evil it does can be reduced appreciably by the methods already pointed out." (Beal, "Some Common Birds in their Relaton to Agriculture.")

Regarding the **Brown Thrasher** (*Toxostoma rufum*), Professor Beal says: "The food of the Brown Thrasher consists of both fruit and insects. An examination of 121 stomachs showed 36 per cent of vegetable and 64 of animal food, practically all insects, and mostly taken in spring before fruit is ripe. Half the insects were beetles, and the remainder chiefly grasshoppers, caterpillars, bugs, and spiders. A few predaceous beetles were eaten, but, on the whole, its work as an insect destroyer may be considered beneficial.

"Eight per cent of the food is made up of fruits like raspberries and currants which are or may be cultivated, but the raspberries at least are as likely to belong to wild as to cultivated varieties. Grain, made up mostly of scattered kernels of oats and corn, is merely a trifle, amounting to only 3 per cent; and, though some of the corn may be taken from newly planted fields, it is amply paid for by the May-beetles, wild fruit, or seeds. Taken all in all, the Brown Thrasher is a useful bird, and probably does just as good work in its secluded retreats as it would about the garden, for the swamps and groves are no doubt the breeding grounds of many insects that migrate thence to attack the farmer's crops." (Beal, "Some Common Birds in their Relation to Agriculture.")

## WRENS.

### *Troglodytidæ.*

The **House Wren** (*Troglodytes aëdon aëdon*) is a tolerably common summer resident of our orchards. "As regards food habits, the House Wren is entirely beneficial. Practically, he can be said to live upon animal food alone, for an examination of 52 stomachs showed that 98 per cent of the stomach contents was made up of insects or their allies, and only 2 per cent was vegetable, including bits of grass and similar matter, evidently taken by accident with the insects. Half of this food consisted of grasshoppers and beetles; the remainder of caterpillars, bugs, and spiders. As the House Wren is a prolific breeder, frequently rearing from twelve to sixteen young in a season, a family of these birds must cause considerable reduction in the number of insects in a garden. Wrens are industrious foragers, searching every tree, shrub, or vine for caterpillars, examining every post and rail of the fence and every cranny in the wall for insects or spiders. They do not, as a rule, fly far afield, but work industriously in the immediate vicinity of their nests. In this way they become valuable aids in the garden or orchard, and by providing suitable nesting boxes they may be induced to take up residence where their services will do most good. Their eccentricities in the selection of a home are well known. Almost anything from an old cigar box to a tomato can, an old teapot, a worn-out boot, or a horse's skull, is acceptable, provided it be placed well up from the ground and out of reach of cats and other prowlers.

"It does not seem possible to have too many Wrens, and every effort should be made to protect them and to encourage their nesting about the house." (Beal, "Some Common Birds in their Relation to Agriculture.")

An evil habit of this Wren is that of destroying the eggs of other small birds by piercing them with its slender bill, and the **Long-billed Marsh Wren** (*Telmatodytes palustris palustris*) has been seen by Mr. Chapman to injure in the same manner the eggs of the Least Bittern (*Ardetta exilis*). This latter Wren "though like the House Wren it eats nothing but insects, cannot be expected to help crops because of the remoteness of its marshy habitat. Five birds were collected. Spiders and beetles (*Calandra oryza, Donacia, Hippodamia maculata*) formed the major part of their food. The minor part was composed of true bugs, leaf-hoppers, flies, parasitic wasps, and ants." (Judd, "Birds of a Maryland Farm.")

The **Winter Wren** (*Nannus hiemalis hiemalis*) lives like the others of its family on insects and spiders.

## CREEPERS.

### *Certhiidæ.*

The **Brown Creeper** (*Certhia familiaris americana*) hunts systematically through our woodland and orchards for insects, flying from the top of one tree to the base of another and searching in the interstices of the bark for eggs as it proceeds slowly up the trunk. "Very few precise determinations of its food have been made: three stomachs examined by King contained small beetles and other insects, and Nelson reports that he has seen several of these Creepers on the sides of a house searching for spiders. In June, 1895, Aughey saw two parent birds bring to a nest of young twenty-seven locusts in an hour. In Maryland, Judd found that one bird had eaten beetles, sawflies, flying ants, spiders, and seeds of the scrub pine. There can be no doubt that this is a very useful little bird, deserving all possible encouragement." (Weed and Dearborn, "Birds in their Relation to Man.")

## NUTHATCHES.

### *Sittidæ.*

Other useful gleaners of the tree trunks and the larger branches are the **White-breasted** and **Red-breasted Nuthatches** (*Sitta carolinensis carolinensis,* and *canadensis*). Regarding the

White-breasted Nuthatch, Weed and Dearborn say: "Professor King examined the stomach contents of twenty-five Wisconsin specimens, and found that fourteen of them had eaten beetles, including elaters and longicorns, while others contained ants, caterpillars, and beetle grubs, a spider, and a chrysalis, a few small toadstools, some acorns, and a little corn. Four Illinois specimens had eaten beetles of various kinds, some of them being lady-beetles.

"The food of this species in winter and spring was made the subject of a special study by Professor E. D. Sanderson. 'During the winter the larger proportion of the food was composed of seeds, which gradually decreased as insect life became more abundant.' Seeds of Indian corn, ragweed, and wild sunflowers were recognized; the insects were largely in egg or larval stages. In spring nearly eighty per cent of the food consisted of insects, chiefly adults. No traces of acorns were found in the stomachs examined. From these studies Professor Sanderson reaches the conclusion that this species is 'either absolutely neutral or of comparatively small economic importance'— a conclusion which, it seems to us, is by no means warranted by his results. During the spring, he writes, 'Hymenoptera were found in considerable numbers, *all being beneficial*.' Probably it is on this account that the usefulness of the birds is doubted. But we believe that investigators err in saying that all parasitic insects are beneficial." (Weed and Dearborn, "Birds in their Relation to Man.")

The feeding habits of the Red-breasted Nuthatch are similar.

## TITMICE.

### *Paridæ.*

Taking up the work where the Creepers and Nuthatches have left it, carrying their search for insects and their eggs to the tips of the branches and the hanging leaves, and often intruding on the ground more properly belonging to the others, common and remaining with us all the year, the **Chickadee** (*Parus atricapillus atricapillus*) is probably the most useful bird we possess. "In a cankerworm-infested orchard sixty-one per cent of the food of two Chickadees consisted of these caterpillars, while injurious beetles constituted the remainder.

"In a recent investigation of the winter food of the Chickadee, we studied the stomach contents of forty-one specimens taken during November, December, January, February, and March. The results as a whole show that more than half of the food of the Chickadees during winter consists of insects, a very large proportion of which are taken in the form of eggs. About five per cent of the stomach contents consisted of spiders or their eggs. Vegetation of various sorts made up a little less than a quarter of the food, two-thirds of which, however, consisted of buds and bud-scales that were believed to have been accidentally introduced with plant-lice eggs. These eggs made up more than one-fifth of the entire food and formed the most remarkable element of the bill of fare. This destruction of the myriads of eggs of plant-lice which infest the fruit, shade, and forest trees, is probably the most important service the Chickadee renders during its winter residence. More than four hundred and fifty eggs sometimes occur as the food of one bird in a single day. On the supposition that one hundred were eaten daily by each of a flock of ten Chickadees, there would be destroyed one thousand a day, or one hundred thousand during the days of winter — a number which we believe to be far below the actual average, could we determine it precisely. Insects' eggs of many other kinds were found in the food of the Chickadee; many of these it was impossible to recognize, but there was no difficulty in identifying the eggs of the common American tent caterpillar and of the fall cankerworm, the eggs of which remain upon the trees through the winter. There were also present the eggs and egg sacs of many spiders of kinds commonly occurring under loose bark. While spiders as a class are doubtless beneficial creatures, the destruction of some of them is not in our opinion seriously detrimental to the usefulness of the Chickadee. The larvæ of several different kinds of moths were also found. One of the most abundant species was believed to be the common apple worm, the larva of the codling moth. The bark beetles of the family Scolytidæ, which are destructive to forests all over our country, were also freely eaten by the Chickadees. The hairy skins of the fruit of the common wild sumachs were among the most abundant elements of the vegetable food present. The edible portion of these fruits is evidently eaten to a considerable extent throughout the winter and early spring. Another common element of the food appears to consist of the curious fruits of the bayberry or waxberry myrtle — an abundant shrub along the seacoast. In winter Chickadees have been observed to hide away surplus food, to eat at a later time.

" A careful study of the food of the Chickadee in Michigan has also been made by Professor E. D. Sanderson, with results very similar to those recorded above. As an indication of the usefulness of these birds, he writes: 'If fifty-five insects were consumed per day by each bird, as will be shown to be the case, three hundred and eighty-five would be consumed per day by a flock of seven, which is believed to be a fair average for each square mile; this would be about one hundred and thirty-seven thousand five hundred per year in each square mile. Thus upon the land surface of Michigan there will annually be about eight thousand million insects destroyed by Chickadees alone — surely no mean number.' " (Weed and Dearborn, " Birds in their Relation to Man.")

Mr. Forbush reports that 1,028 eggs of the fall cankerworm were found in the stomachs of four Chickadees killed in Massachusetts, and that four others taken later in the season had eaten 105 female imagoes of the spring canker worm, each moth containing on the average 185 eggs. " Mr. Bailey is very positive from his continuous field observation, that each Chickadee will devour on the average 30 female cankerworm moths per day from the 20th of March until the 15th of April, provided these insects are plentiful. If the average number of eggs laid by each female is 185, one Chickadee would thus destroy in one day 5,550 eggs, and in the twenty-five days in which the cankerworm moths ' run ' or crawl up the trees, 138,750. It may be thought that this computation is excessive, and it is probable that some of the moths were not captured until they had laid some of their eggs, but the Chickadees are busy eating these eggs also. When we consider further that 41 of these insects, distended as they were with eggs, were found at one time in the stomach of one Chickadee, and that the digestion of the bird is so rapid that its stomach was probably filled many times daily, the estimate made by Mr. Bailey seems a very conservative one. He now regards the Chickadee as the best friend the farmer has, for the reason that it is with him all the year, and there is no bird that can compare with it in destroying the female moths and their eggs." (Forbush, "Birds as Protectors of Orchards.")

## KINGLETS.

### *Sylviidæ.*

Our **Golden** and **Ruby-crowned Kinglets** (*Regulus satrapa satrapa* and *R. calendula calendula*) carry on the work of the Chickadees to the flowers and to the leaf-buds, which their diminutive size allows them to investigate. Regarding the Golden-crowned Kinglet Professor King says: "Of nine specimens examined, two had eaten twelve small diptera; three, nine small beetles; one, four caterpillars; one, a small chrysalis; and three, very small bits of insects, too fine to be identified."

Of the Ruby-crowned Kinglet he says: "Of seven specimens examined, two had eaten four small caterpillars; three, five beetles; one, an ant; one, a chalcis fly; and two, bits of insects not identified." (King, "The Economic Relation of Wisconsin Birds," in Chapman, "The Economic Value of Birds to the State.")

## THRUSHES, ROBINS, and BLUEBIRDS.

### *Turdidæ.*

Our **Thrushes** are all insectivorous, and in feeding habits closely resemble each other. "In summarizing the food of the family of Thrushes as it occurs in Illinois, Professor Forbes says: 'Sixty-one per cent of the food consists of insects, one per cent of spiders, two per cent of myriapods, and thirty-two per cent of fruits, eleven per cent being blackberries, eight per cent cherries, one per cent currants, and five per cent grapes. Thirty parts of the food consist of injurious insects, and eight parts of beneficial species, while twenty-six parts consist of edible fruits. This, however, refers only to the adult birds, the food of the young not being sufficiently known to be included in the estimate. All the observations on record indicate that the nestlings of Thrushes are fed upon insects, especially smooth caterpillars like the cutworms, so that there is little doubt that this factor would largely increase the already conclusive evidence as to the great value of this splendid family.' " (Weed and Dearborn, " Birds in their Relation to Man.")

Of the **Wood Thrush** (*Hylocichla mustelina*) Mr. Chapman says: " Professor Forbes writes, after examining the contents of twenty-two birds of this species: ' Seventy-one per cent of their food consists of insects, and twenty per cent of fruit, a small ratio of spiders and mollusks, and an unusually large percentage of Myriopoda making up the remainder.' After discussing in detail the bird's economic relations, the same author adds: ' Its advances, therefore, are to be cordially encouraged by the gardener and farmer — a fact which must be especially agreeable to every lover of bird music, who has learned to recognize the full, clear, rich, exquisite strains of this songster.' " (Chapman, " The Economic Value of Birds to the State.")

The stomachs of three **Gray-cheeked Thrushes** (*Hylocichla aliciæ aliciæ*) collected in May were found by Dr. Judd to contain sawfly larvæ, ants, caterpillars, May-flies, ground beetles, weevils, and scarabæid beetles; while two **Olive-backed Thrushes** (*Hylocichla ustulata swainsoni*), also collected in May, had eaten ants, wasps, ground beetles, darkling beetles, and ground spiders.

Regarding the **Hermit Thrush** (*Hylocichla guttata pallasi*), Professor Forbes reports as follows on the food contents of the stomachs of twenty-one Hermit Thrushes: " Eighty-four per cent of the food consisted of insects, four per cent of spiders, and twelve per cent of thousand-legs. Ants amounted to fifteen per cent, Lepidoptera to nineteen per cent, including a few Phalænidæ, and Diptera only to three — chiefly the larvæ of *Bibio*. Coleoptera make thirty per cent of the food, eleven per cent being Carabidæ." (Forbes, " The Food of Birds ": Bull. 3, Illinois State Laboratory of Nat. Hist.)

The food of the **Wilson's Thrush** (*Hylocichla fuscescens fuscescens*) is doubtless similar to that of our other Thrushes; but, were its only claim on our regard its " clear, bell-like notes, resonant, distinct, yet soft and of indescribable sadness," it would still well deserve protection.

The **American Robin** (*Planesticus migratorius migratorius*) needs no introduction. " With the exception of the English Sparrow and possibly the Crow, the economic status of no American bird has been discussed so fully and freely as that of the

Robin. Appearing early in the spring and remaining late in the autumn in regions where it does not reside throughout the year, commonly frequenting lawns and meadows, building conspicuous nests near the haunts of man, feeding freely upon the fruits of the garden and orchard, greeting the rising and the setting sun with bursts of no mean melody — these and other considerations have combined to render the Robin familiar to every lover of the outdoor world." (Weed and Dearborn, "Birds in their Relation to Man.") But, while the evidence is strongly against the English Sparrow and hardly in favor of the Crow, there can be no doubt that, in spite of its taste for fruit, the Robin is a very useful bird and should be thoroughly protected. Professor Forbes found that 99 per cent of the food of 11 Robins shot in February in Illinois consisted of insects, of which cutworms and other caterpillars constituted 14 per cent, and the larvæ of the white-winged *Bibio* 76 per cent. "Thirty-seven per cent of the food of nine March robins consisted of *Bibio* larvæ; cutworms and other caterpillars formed 30 per cent." "Taking the year as a whole, insects form almost two-thirds of the food of the Robin." "Six robins shot in Nebraska by Professor Aughey had eaten two hundred and sixty-five Rocky Mountain locusts and eighty-four other insects. In Wisconsin Professor King examined the stomachs of thirty-seven specimens taken during the interval between March and October. 'Five birds had eaten eleven cutworms; three, five wire-worms; two, two hairy caterpillars; one, a hog-caterpillar of the vine; five, eight scarabæid beetles; two, curculios; one, a click beetle; one, an ichneumon fly; two, two spiders; one, a millipede; two, two angle-worms; six, nine grasshoppers; two, eight grasshoppers' eggs; one, a moth; three (young birds), pellets of grass; one, choke-cherries; two, black cherries; one raspberries; one, grapes; one, sheep berries; and one, berries of Indian turnip.'"

"Concerning the fruit-eating proclivities of the Robin, Mr. W. J. Green, of the Ohio Agricultural Experiment Station, writes: 'The capacity of the Robin for berries is enormous, and when hundreds come at once the growers suffer serious losses. On the station ground nearly all of the early raspberries and blackberries are taken by the Robins, and only in the height of the season are there enough berries left to give the pickers a chance to earn fair wages. If left to themselves the Robins would take the greater share of the black raspberries that grow on a plantation of more than an acre. Growers in other parts of the country have complained of losses quite as large.'

"The above accounts relate to the food of the adult Robins. We have next to consider that of the nestlings. Properly to appreciate the importance of the latter, we must remember that as far north as Massachusetts three broods of nestlings are commonly reared; that from early spring till late in the summer each pair of old birds is engaged at least half of the time in providing food for four, five, or six ravenous birdlings; and that each of the latter probably requires more food while in the nest than does one of the adults during the same period. It seems to us that the chief claim of the Robin upon man's favor rests upon these facts.

"In 1884 we examined the stomach contents of six young Robins from Michigan nests. The largest single element of the food consisted of cutworms and related caterpillars, which formed twenty-seven per cent of the total dietary. Among other insects present were seven per cent of beetles, including curculios and ground beetles and various undetermined species. There were also present twenty per cent of earthworms, one per cent of snails, three per cent of myriapods, and about thirty per cent of grass blades. The latter seem almost always to be found in the stomachs of nestling Robins; they may be introduced accidentally with the cutworms or possibly may have a dietetic value.

"The food of fourteen nestlings examined by Beal consisted of caterpillars, locusts, grasshoppers, crickets, and beetles, with a few spiders, snails, and earthworms, and seven per cent of berries of various kinds." (Weed and Dearborn, "Birds in their Relation to Man.")

"An examination of 330 stomachs shows that over 42 per cent of its food is animal matter, principally insects, while the remainder is made up largely of small fruits or berries. Over 19 per cent consists of beetles, about one-third of which are useful ground beetles, taken mostly in spring and fall, when other insects are scarce. Grasshoppers make up about one-tenth of the whole food, but in August comprise over 30 per cent. Caterpillars form about 6 per cent, while the rest of the animal food, about 7 per cent, is made up of various insects, with a few spiders, snails, and angle-worms. All the grasshoppers, caterpillars, and bugs, with a large portion of the beetles, are injurious, and it is safe to say that noxious insects comprise more than one-third of the Robin's food.

"Vegetable food forms nearly 58 per cent of the stomach contents, over 47 being wild fruits, and only a little more than 4 per cent being possibly cultivated varieties. Cultivated fruit amounting to about 25 per cent was found in the stomachs in June and July, but only a trifle in August. Wild fruit, on the contrary, is eaten in every month, and constitutes a staple food during half the year. No less than forty-one species were identified in the stomachs; of these the most important were four species of dogwood, three of wild cherries, three of wild grapes, four of greenbrier, two of holly, two of elder; and cranberries, huckleberries, blueberries, barberries, service-berries, hackberries, and persimmons, with four species of sumac, and various other seeds not strictly fruit. The depredations of the Robin seem to be confined to the smaller and earlier fruits; and few, if any, complaints have been made against it on the score of eating apples, peaches, pears, grapes, or even late cherries. By the time these are ripe the forests and hedges are teeming with wild fruits, which the bird evidently finds more to its taste. The cherry, unfortunately, ripens so early that it is almost the only fruit accessible at a time when the bird's appetite has been sharpened by a long continued diet of insects, earthworms, and dried berries; and it is no wonder that at first the rich, juicy morsels are greedily eaten. In view of the fact that the Robin takes ten times as much wild as cultivated fruit, it seems unwise to destroy the birds to save so little. Nor is this necessary, for by a little care both may be preserved. Where much fruit is grown, it is no great loss to give up one tree to the birds; and in some cases the crop can be protected by scarecrows. Where wild fruit is not abundant, a few fruit-bearing shrubs and vines judiciously planted will serve for ornament and provide food for the birds. The Russian mulberry is a vigorous grower and a profuse bearer, ripening at the same time as the cherry, and, so far as observation has gone, most birds seem to prefer its fruit to any other. It is believed that a number of these trees planted around the garden or orchard would fully protect the more valuable fruits." (Beal, "Some Common Birds in their Relation to Agriculture.")

The **Bluebird** (*Sialia sialis sialis*) "frequents orchards and gardens, where it builds its nest in hollow trees or takes advantage of a nesting box provided by the enterprising farmer's boy.

"So far as known this bird has not been accused of stealing fruit or of preying upon any crops. An examination of 295 stomachs showed that 76 per cent of the food consists of insects and their allies, while the other 24 per cent is made up of various vegetable substances, found mostly in stomachs taken in winter. Beetles constitute 28 per cent of the whole food, grasshoppers 22, caterpillars 11, and various insects, including quite a number of spiders, comprise the remainder of the insect diet. All these are more or less harmful, except a few predaceous beetles, which amount to 8 per cent; but, in view of the large consumption of grasshoppers and caterpillars, we can at least condone this offense, if such it may be called. The destruction of grasshoppers is very noticeable in the months of August and September, when these insects form more than 60 per cent of the diet.

"It is evident that in the selection of its food the Bluebird is governed more by abundance than by choice. Predaceous beetles are eaten in spring, as they are the first insects to appear; but in early summer caterpillars form an important part of the diet, and are replaced a little later by grasshoppers. Beetles are eaten at all times, except when grasshoppers are more easily obtained.

"So far as its vegetable food is concerned, the Bluebird is positively harmless. The only traces of any useful product in the stomachs consisted of a few blackberry seeds, and even these more probably belonged to wild than cultivated varieties. Following is a list of the various seeds which were found: blackberry, chokeberry, juniper berry, pokeberry, partridge berry, greenbrier, Virginia creeper, bittersweet, holly, strawberry bush, false spikenard, wild sarsaparilla, sumac (several species), rose haws, sorrel, ragweed, grass, and asparagus. This list shows how little the Bluebird depends upon the farm or garden to supply its needs, and indicates that, by encouraging the growth of some of these plants, many of which are highly ornamental, the bird can be induced to make its home on the premises." (Beal, "Some Common Birds in their Relation to Agriculture.")

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## State of Connecticut

# FIFTH BIENNIAL REPORT OF THE COMMISSIONERS

OF THE

# State Geological and Natural History Survey

1911-1912

BULLETIN No. 21

# State of Connecticut

PUBLIC DOCUMENT No. 47

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# State Geological and Natural History Survey

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# FIFTH BIENNIAL REPORT OF THE COMMISSIONERS

OF THE

# State Geological and Natural History Survey of Connecticut

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1911-1912

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HARTFORD
Published by the State
1912

HARTFORD, CONN., December 31, 1912.

HIS EXCELLENCY, SIMEON E. BALDWIN, Governor of Connecticut,
*Hartford, Connecticut.*

*Sir:* — I have the honor to transmit to you herewith, in behalf of the Connecticut Geological and Natural History Survey Commission, the report of the Superintendent of the work, covering the period of two years ending December 31, 1912.

Very respectfully,
FLAVEL S. LUTHER,
*Secretary of the Commission.*

# STATE GEOLOGICAL AND NATURAL HISTORY SURVEY

## FIFTH BIENNIAL REPORT

### Coöperation with United States Geological Survey in Study of Water Resources

In the Report of the Commissioners of the State Geological and Natural History Survey to the General Assembly in 1911, it was intimated that two plans were under consideration for the inauguration of a kind of work different from that in which the Survey had been engaged in previous years and having a somewhat more direct economic bearing. The two projects under consideration were a survey of the soils of Connecticut, and a survey of the water resources of Connecticut. After thorough investigation, it was decided that the latter project was the more desirable of the two. Accordingly, in the past two years the bulk of the appropriation of the State Geological and Natural History Survey has been applied to an investigation of the water resources of the state.

One consideration making it desirable to enter upon the investigation of the water resources of the state at this time, was that the United States Geological Survey was ready to coöperate in such investigation, appropriating from the United States Treasury an amount equal to that which was appropriated from the State Treasury. It was therefore practicable for us, by the use of $2,000 of the appropriation made by the State of Connecticut, to secure for the work on the water resources the expenditure of a total amount of $4,000.

Investigation of the water resources of the state seemed to the Commissioners of the State Survey especially timely, in view of the fact that most of the large towns of Connecticut have, in recent years, been on the verge of suffering from water famine. The consumption of water, both for domestic and manufacturing purposes, is rapidly increasing with the growth of our population and the increased development of manufactures. In addition to other uses of water, it is evident that in the near future increased attention must be given to the development of water power. The exploitation of the national supply of coal is going on with increasing rapidity, and in the consumption of coal we are using not our income but our capital. The available supply of coal

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tends to exhaustion, and the diminished supply must mean in the near future a considerable increase in the cost. It is evident, then, that in the near future our manufacturing industries must depend more largely than in the past upon some cheaper form of power than that which is afforded by the combustion of coal.

It is believed, also, that irrigation is destined to play a large part in the future development of the agriculture of Connecticut. There is, of course, no such necessity for irrigation in Connecticut as exists in the arid region of the country. The average rainfall for Connecticut is sufficient for agricultural use; but our rainfall is more or less irregular, and our farmers often suffer heavy losses from occasional long periods of drouth. It is practicable, by means of irrigation, not only to carry on agriculture in localities where the rainfall is always insufficient, but to avoid the heavy losses to agriculture from occasional periods of drouth in districts ordinarily well watered.

In view of the growing demands upon our water supply, it is evidently fitting that there should be a thorough study of our water resources. The streams should be gaged, that we may know their rates of flow in different seasons of the year and their fluctuation in different years. The gaging of the streams must, therefore, be carried on not for one year but for a term of several years, in order that the necessary data may be obtained. Profiles of the streams should be constructed so as to indicate suitable sites for storage reservoirs and for the development of water power.

The underground waters of the state should also be studied. Already our population is coming to rely largely upon deep wells for manufacturing and other purposes. The geological structure of Connecticut is not such as to make it possible to say with approximate certainty, as can be done in some parts of the country, at what depth an abundant supply of water can be encountered. But it is believed that a careful study of wells and springs throughout the state will render it possible to map the distribution of ground water in such a way that the search for an underground supply of water will not be so completely a lottery as it is at present.

In view of these considerations, it was determined by the Commissioners to apply $2,000 of our appropriation to coöperative work with the United States Geological Survey on the water resources of the state. The following contract was accordingly signed by the Director of the United States Geological Survey and the Superintendent of the State Geological and Natural History Survey of Connecticut.

"THIS AGREEMENT, made and entered upon this 31st day of May, 1911, by and between GEORGE OTIS SMITH, DIRECTOR, for and on behalf of the UNITED STATES GEOLOGICAL SURVEY, the first party, and WILLIAM N. RICE, SUPERINTENDENT, for and on behalf of the CONNECTICUT STATE GEOLOGICAL AND NATURAL HISTORY SURVEY, the second party, WITNESSETH:

"1. That there shall be maintained within the State of Connecticut a coöperative survey of water resources, which shall consist of such studies of the occurrence, amount, and availability of underground waters, and of the sources, capacity, and availability for economic use of the rivers and streams, as shall be necessary to enable the people of the State of Connecticut to make the most comprehensive development thereof.

"2. That the investigations shall be under the supervision of the first party, who shall be represented in all work, negotiations, and disbursements involved in the performance of this agreement by a duly accredited representative, whose agency shall be formally certified to for the information and guidance of the second party; that the methods of investigation shall be those usually followed by the first party, and they shall be subject to such modification or improvement as may be suggested by the second party and approved by the first party.

"3. That the location of the investigations and the character thereof shall be from time to time determined upon by the parties hereto or their duly accredited representatives; and, during the progress of the work, all notes, maps, measurements, gagings, and other material shall be open to the inspection of the second party, and, if the work is not being carried on in a manner satisfactory to said party, he may on formal notice terminate this agreement.

"4. That the first party shall contribute toward the maintenance of the work herein provided the sum of one thousand dollars ($1,000) to be expended during the fiscal year ending June 30, 1912, and a further sum of one thousand dollars ($1,000) to be expended during the fiscal year ending June 30, 1913; PROVIDED, That, should the Congress of the United States fail to make provision for the water resources investigations of the first party in suitable amount to enable said party, under an equitable distribution of its appropriation for this purpose, to continue the work herein provided during the year ending June 30, 1913, this agreement shall lapse on June 30, 1912; that the second party shall allot for the investigations herein provided the sum of two thousand dollars ($2,000), which shall be expended on or before June 30, 1913; that the accounts for the work herein provided shall, except as above specified, be rendered against the allotments of either party, the same to be determined upon by said parties or their respective representatives, according to convenience, or to the balance remaining in the respective allotments; PROVIDED, That all expenses shall eventually be divided between the two agreeing parties in such a way that they shall be equal on June 30, 1913.

"5. That the results of the investigations, surveys, observations, measurements, and computations, and all other matters acquired in the due performance of this agreement, shall become the property of the first party, certified copies thereof to be delivered to the second party on demand.

"6. That the results of the work contemplated in this agreement, together with the interpretations thereof, will be published by the first party, said publications to contain full and complete statements of the relation thereto of each party as set forth in this agreement; that these publications shall be made as soon as possible after completion of each unit piece of work which may be determined upon by said parties as of suitable scope for a separate publication, and the cost of such publications shall not be included in the allotments made by either party; PROVIDED, That nothing herein shall act to prevent the second party from compiling and arranging for independent publication any of the results collected under the terms of this agreement; PROVIDED FURTHER, That in such independent publication the relation of the first party thereto shall be clearly stated.

"IN WITNESS WHEREOF, We have hereunto set our hands and seals the day and year first herein written.

GEO. OTIS SMITH,
*Director, United States Geological Survey,*
*The First Party.*

WM. NORTH RICE,
*Superintendent, Connecticut State Geological and Natural History Survey, The Second Party."*

From the foregoing contract it will be seen that the work has been carried on under the direction of the United States Geological Survey. It has been placed under the charge of Professor Herbert E. Gregory, of Yale University. Professor Gregory has given very much attention to the study of water resources, and his paper on Underground Water Resources of Connecticut, published in 1909 as Water-Supply Paper 232 of the United States Geological Survey, is the best statement extant of our present knowledge in regard to that subject. It is certain that no man could have been selected better qualified to take charge of this investigation.

It will be seen from the contract that the results of the work, when ready for publication, are to be published by the United

States Geological Survey in the usual form of their publications, and at the expense of the United States. The contract, however, gives to us the right to republish any part of these results in the series of Bulletins of the State Geological and Natural History Survey; provided, only, that, in any form of publication of a special Connecticut edition, credit shall be given to the United States Geological Survey for their share in the work.

## Work on Water Resources during the Past Two Years

The total appropriation of four thousand dollars (two thousand from the United States and two thousand from the State of Connecticut) has of course sufficed only for a very modest beginning of the survey of our water resources. It has been deemed best to use the whole amount in a study of underground waters in certain selected areas. The field work has been done, under the direction of Professor Gregory, by Arthur J. Ellis, M.A., Junior Geologist, U. S. Geological Survey. The following account of his work is quoted from a letter of Mr. Ellis to the Superintendent of the State Survey.

" Under the direction of Prof. H. E. Gregory, I have studied the water supplies, with especial attention to underground waters, in selected areas in Connecticut, which represent the typical geologic conditions of the state. These areas are:

" 1. The Hartford area, including the towns of Hartford, West Hartford, Newington, Wethersfield, Manchester, East Hartford, South Windsor, East Windsor, Windsor, and Bloomfield.

" 2. The Stamford area, including Stamford and Greenwich.

" 3. The Canaan-Salisbury area, including Canaan, North Canaan, and Salisbury.

" 4. The Willimantic area, including Windham and Franklin.

" 5. The Saybrook area, including Saybrook, Essex, Westbrook, and Old Lyme.

" In each of these areas the towns have been studied as units, and the results are to be given on the same basis, but grouped with reference to the areas. A map of each town has been prepared, upon which are shown data relating to underground waters, and contour lines representing the position of ground water with reference to the land surface. In the Hartford area the rock surface is also shown by contour lines. In all except the Hartford area, these maps will show the distribution of timber and tillage, and of rock outcrops and Glacial drift.

" Field assays have been made of several hundred samples of water taken from springs, dug wells, drilled wells, and brooks.

An effort has been made to obtain data concerning all the drilled wells in the areas studied, and as many dug wells have been examined as were deemed necessary to locate the position of the water-table throughout the areas, and to supply a general knowledge of the condition of dug wells, and the amount and quality of water obtained from them."

## Coöperation with United States Geological Survey in other Work

It is proper here to mention the fact that the work on the water resources of the state is not the only work in which there has been coöperation between the United States Geological Survey and the State Survey of Connecticut. In the study of the peat deposits of the state, a work of great importance, both scientific and economic, in regard to which a bulletin is soon to be published, the State Survey was greatly aided by the generous coöperation of the United States Geological Survey, as is stated more fully on page 19 of this report. In another instance, we were able to render some service to the United States Geological Survey. When Professor T. M. Dale was working on a bulletin on the Granites of Connecticut for the United States Geological Survey, he requested the Superintendent of the State Survey to furnish an introductory chapter on the general geological relations of the granites of the state. Such a chapter was accordingly prepared by Professor H. E. Gregory, author of the chapter relating to the crystalline rocks in Rice and Gregory's Manual of the Geology of Connecticut (Bulletin 6 of the State Survey). Bulletin 484 of the United States Geological Survey, on the Granites of Connecticut, accordingly bears on its title-page the words, "Prepared in coöperation with the Geological and Natural History Survey of Connecticut."

## General Scope and Plan of the State Survey

While it has been deemed best to devote the bulk of the appropriation for the past two years to the coöperative work on the water resources of the state, and to undertake no other new work, it is not forgotten that the scope of the Survey, as defined in the act of 1903 by which the Survey was established, is much broader. That act proposed for the Survey two subjects for investigation; viz., the geology of the state, and the natural history, or botany and zoölogy, of the state. It has been presumed to be the intent of the law that the appropriation should be divided with some approach to equality between geology and biology. The law further specifies three aims with reference to which the work should be prosecuted: — first, the purely scientific aim of advancing our knowledge of the geology and natural history of the state; second, the economic aim of leading to the most effective conservation and utilization of the resources of the state; third, the educational aim of promoting the work of the schools of the state by the publication of the results of investigation in a form adapted for the use of teachers.

It will be appropriate to outline briefly the plans adopted for the carrying out of these objects, and the work which has been already accomplished, or which is in progress.

The plan of organization which was outlined in the first report has been retained. Only one salaried officer has been appointed by the Commissioners; viz., the Superintendent. Other scientific men have been engaged to investigate particular subjects and prepare reports or bulletins thereon. In the great majority of cases, the terms of contract with these scientific men have been that the investigator should receive a certain sum as compensation when the bulletin presented was accepted by the Superintendent, and that a certain allowance should also be made for the expenses of the work, the allotment for expenses to be drawn upon from time to time as the expenses were actually incurred. In some cases, however, this form of contract has been impracticable, as investigations have been commenced and prosecuted in regard to which it could not be foreseen how soon they would result in conclusions definite enough for publication. In such cases the agreement has been to pay the investigator a small sum per diem, a maximum limit being prescribed in every such case.

Each report prepared is published as a separate bulletin, the bulletins being numbered consecutively, generally in the order in which they are received. Each bulletin bears the name of the author or the names of the authors, and each author is responsible for his own work. The bulletins are issued in paper covers, but a part of the edition is reserved for binding. Bulletins 1 to 5 have been bound as Vol. I., Bulletins 6 to 12 as Vol. II., and Bulletins 13 to 15 as Vol III. The bound volumes are especially desirable for public libraries and similar institutions, in which complete sets of our publications are to be preserved. The pamphlet form, in which each bulletin is complete in itself, is convenient for the large number of students, teachers, and others who have use for some particular bulletin. The publications of the Survey are distributed by the State Librarian. They are given liberally to colleges, public libraries, geological surveys, and other scientific institutions, and to scientific men of repute in the branches of science with which the respective bulletins are concerned. In many cases books and papers of great value are received in exchange for the publications of the Survey. All books and papers thus received are deposited in the State Library. The publications of the Survey are also distributed liberally to citizens of our own state, particularly to teachers who can make use of them in their work. In the case of persons in other states who are not known as scientific men, and who appear to have no special claim for the donation of the publications of the Survey, the bulletins are sold at prices sufficient to cover the cost of printing and transportation.

### Bulletins already Published

The following is the list of the bulletins already published: —

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.
2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.
3. A preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.
4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.
5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.
6. Manual of the Geology of Connecticut: by William North Rice and Herbert Ernest Gregory.
7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory and Henry Hollister Robinson.
8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.
9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.
10. A preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn and Lucia Washburn (Hazen) Webster.
11. The Bryophytes of Connecticut: by Alexander William Evans and George Elwood Nichols.
12. Third Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1907-1908.
13. The Lithology of Connecticut: by Joseph Barrell and Gerald Francis Loughlin.
14. Catalogue of the Flowering Plants and Ferns of Connecticut growing without cultivation: by a Committee of the Connecticut Botanical Society.
15. Second Report on the Hymeniales of Connecticut: by Edward Albert White.
16. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part I. General Introduc-

tion: by Wilton Everett Britton. Part II. The Euplexoptera and Orthoptera of Connecticut: by Benjamin Hovey Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

18. Triassic Fishes of Connecticut: by Charles Rochester Eastman.

19. Echinoderms of Connecticut: by Wesley Roscoe Coe.

Four of these, viz., Bulletins 13, 16, 18, and 19, have been published since the last biennial report.

Bulletin 13, on the Lithology of Connecticut, includes a general introduction to lithology by Professor Barrell, of Yale University, and a special description of forty-one typical rocks from Connecticut localities by Dr. Loughlin, of Massachusetts Institute of Technology. In the general part of the work, lithology is treated in relation to mineralogy and dynamical geology, so that the student may learn somewhat of the agencies by which the different types of rocks are produced, as well as their composition and characteristic aspect. In both the general and the special part of the work attention is given chiefly to those characteristics of rocks which can be recognized by the naked eye or by the simple microscope, with comparatively little reference to the phenomena which can be observed only by the examination of thin sections under the compound polarizing microscope. This limitation in the treatment of the subject renders the work adapted to the use of comparatively elementary students. The usefulness of the work in the educational institutions of the state will be greatly enhanced by suites of specimens of rocks from the typical localities described in the special part of the paper, which have been distributed to colleges, normal schools, high schools, and academies in the state, on condition that the respective institutions should pay the cost of transportation. Any suites of specimens remaining in the possession of the Survey after such distribution will be sold and the money paid into the treasury of the state.

Bulletin 16, on the Insects of Connecticut, forms the beginning of a series of papers on that class of animals, whose publication may be distributed through a considerable number of years. It is needless to comment on the economic importance of the class of insects, many insects being among the worst enemies of the agriculturist, while others, insectivorous or parasitic in habit, tend to hold in check the destroyers of agricultural products. The various parts of the work will be written by specialists on various groups, under the general direction of Doctor Britton, Entomologist of the Connecticut Agricultural Experiment Station. The present bulletin includes two parts of the proposed work. Part I. gives a brief outline of the general characters of insects and their relations to other allied groups of animals, the classification of the group, and their economic relations. In Part II., Mr. Walden gives a catalogue, with analytical keys, of the two orders, Euplexoptera and Orthoptera. The former order is a small and comparatively insignificant one, including the insects commonly called earwigs. By many entomologists the Euplexoptera have been regarded as merely a subdivision of the Orthoptera. The Orthoptera constitute a larger and more important order, including, besides some less familiar forms, the cockroaches, the locusts and grasshoppers, the katydids, and the crickets. The mere mention of the names, locust and grasshopper, is enough to suggest the importance of the economic relations of the Orthoptera. Part I. of this bulletin is illustrated by a series of plates, representing typical examples of all the principal orders of insects. Part II. is illustrated by a number of plates from photographs of entire insects representing different groups of Orthoptera, and by numerous figures in the text from drawings of diagnostic parts of the anatomy of various families and genera.

Bulletin 18, on the Triassic Fishes, by Professor Eastman, of the University of Pittsburgh, is a very important contribution to the paleontology of the state. The area of Connecticut is by no means rich in fossils. The crystalline rocks of the eastern and western highlands have proved as yet utterly barren of fossils. Whatever fossils some of these rocks may have once contained have been entirely obliterated by the processes of metamorphism. The Triassic formation of the Connecticut Valley has afforded scarely any fossils, excepting tracks of reptiles and amphibians on some of the beds, and remains of fishes and a few species of plants in two or three thin strata of black shale intercalated among the red shales and sandstones. The scantiness of fossils in this formation has made difficult the determination of its geological age. Professor Eastman has made a very careful study of all the important collections of the fossil fishes of this formation. He has been able thus to make a more exact determination of some features of the anatomy of the animals than has been made before. He has also made comparisons of the fish fauna of our Connecticut beds with the fish faunas of other Triassic formations in various parts of the world. This comparison leads him to the opinion that the age of our Connecticut formation corresponds most nearly, not with the uppermost European Trias (Keuper or Rhætic), as has been of late generally supposed, but rather with a somewhat lower horizon, near the boundary between the Muschelkalk and the Keuper.

Bulletin 19, by Professor Coe, of Yale University, on the Echinoderms of Connecticut, will be the first paper published by the Survey on the marine zoölogy of the state. The

Echinoderms include the creatures commonly called sea-urchins and starfishes. Though not a large class as regards the number of species, the Echinoderms are an interesting group. They are among the marine animals which are large and conspicuous, and most of them have skeletons which are readily preserved. They are accordingly among the forms which attract the attention of visitors to the shore. Professor Coe's full descriptions of our species will be useful to teachers, particularly in the towns along the coast, where the pupils may easily become acquainted with these animals. One genus of the Echinoderms, the common starfish, is of great economic interest, since it is one of the most destructive enemies of the oyster. Professor Coe has given much attention to the relation of the starfish to the oyster industry. The work is beautifully illustrated with plates showing the aspect of the living animals, and others showing their anatomical structure.

## BULLETINS IN PRESS OR APPROVED FOR PUBLICATION BY THE BOARD OF CONTROL

One bulletin is now in press; and two others have been approved for publication by the Board of Control, but have not yet gone to press on account of an unexpected delay in the revision of the manuscript. These are the following:—

20. The Birds of Connecticut: by John Hall Sage and Louis Bennett Bishop, assisted by Walter Parks Bliss.
22. Guide to the Insects of Connecticut: prepared under the direction of Wilton Everett Britton. Part III. Hymenoptera of Connecticut: by Henry Lorenz Viereck.
23. The Peat Deposits of Connecticut: by Charles Albert Davis.

Probably no work which the Survey has announced as in preparation has been awaited by so many people, in the state, and out of it, with eager expectation, as the work of Mr. Sage and Dr. Bishop on the Birds of Connecticut. In their careful studies, continued for many years, a vast amount of information has been recorded in regard to the dates of arrival and departure of our migratory birds, the localities of rare birds, and the food and habits of the birds. This bulletin will be of interest not only to ornithologists, but also to teachers and farmers, and to the multitude of people who have learned to love the birds. The publication of this bulletin will help to correct some erroneous impressions, widely prevalent among farmers, in regard to some of our birds. Many of the birds of prey, for instance, which are commonly regarded as the farmer's foes, are really his friends. In fact, the sharp-shinned hawk, Cooper's hawk, and the great horned owl, are probably the only birds of prey that are in any considerable degree injurious to agriculture in Connecticut. It is matter of regret that the publication of this bulletin has been so long delayed, owing to the pressure of other duties and cares which made it impossible for the authors to give the amount of time necessary for the completion of the work. Happily a very competent editorial assistant was found in W. P. Bliss, M.A., of Columbia University. Mr. Bliss is himself an earnest student of the birds, and his general training has given him an excellent fitness for editorial work. By his work in the collation of the notes of Mr. Sage and Dr. Bishop, it has been made possible to bring this valuable bulletin to completion.

Bulletin 22, by Mr. Viereck, of the United States National Museum, forms the second instalment of the work on the Insects of Connecticut, under the general direction of Dr. Britton, of the Connecticut Agricultural Experiment Station. It deals with the Hymenoptera, which form one of the largest and most important of the orders of insects. The marvelous instincts and habits of bees, wasps, and ants have always attracted the interest of thoughtful observers. Many of the Hymenoptera are of very great economic interest. The bees, by their transportation of pollen from flower to flower, are indispensable for the fertilization and consequent propagation of a great many plants. Many of the smaller Hymenoptera, as the ichneumon flies, are parasitic upon other insects, and thus serve to keep in check insects which would otherwise be destructive pests to the agriculturalist. Some of the Hymenoptera, on the other hand, as the saw-flies, are themselves prominent among the destroyers of agricultural products. Mr. Viereck is himself a specialist on some of the groups of Hymenoptera, and he has had the aid of a number of collaborators who are specialists on other groups of this large and varied order. Among the writers who have contributed chapters to the work, are the following:—Alexander Dyer MacGillivray, Assistant Professor of Entomology and Invertebrate Zoölogy in Cornell University; Charles Thomas Brues, Curator of Invertebrate Zoölogy, Public Museum, Milwaukee, Wis.; William Morton Wheeler, Professor of Economic Entomology in Harvard University.

Bulletin 23 treats of the Peat Deposits of Connecticut. Like other regions covered by the great ice sheets of the Glacial period, the surface of Connecticut was left dotted with innumerable lakes and ponds, many of which have been converted into peat bogs by the accumulation of the débris of vegetation. The peat is not only of great scientific interest, both to the geologist and to the botanist, but possesses considerable economic importance, having uses as a fuel and as a fertilizer, and being capable also incidentally of employment for various other purposes. Attention has recently been called to the economic value of peat by the investigations of the United States Geological Survey, which have shown its special fitness for use in the gas-producer. It was, therefore, deemed desirable to make a special investigation of the peat deposits of Connecticut, and this was rendered practicable by the generous coöperation of the United States Geological Survey. During the summer of 1907 the field work of the investigation was substantially finished. The localities of all the important peat bogs of the state were visited, the area of those bogs was noted, their depth was determined by a sounding apparatus, and samples for analysis were collected from various depths. This work was accomplished by E. C. Miller, A.B., and T. T. Giffen, A.B., of Yale University. Professor C. A. Davis, of the United States Bureau of Mines, who was employed by the United States Geological Survey in the summer of 1907 for a reconnoissance of the peat deposits of the Atlantic border of the country from Maine to Florida, was permitted by the courtesy of the United States Geological Survey to spend a few days in Connecticut at the beginning of the season of field work. He was able, therefore, to give Messrs. Miller and Giffen the necessary instruction in regard to methods of work. The bulletin which is now nearly ready for publication, will contain a general paper on the scientific and economic relations of peat, by Professor Davis, who has made himself eminently an authority on the subject. It will also contain a digest of the notes of Messrs. Miller and Giffen in regard to their field work. A selection of samples collected by Messrs. Miller and Giffen have been analyzed in the laboratory of the United States Geological Survey, and reports of those analyses will be included in the bulletin. The State Survey is very greatly indebted to the liberality of the United States Geological Survey for the all-important assistance of Professor Davis at the beginning of the investigation, and for the analyses made in the laboratory of the United States Geological Survey. The attention which has recently been given to the scientific and economic relations of peat has brought into notice the valuable work on peat from the chemical standpoint done many years ago by Professor S. W. Johnson, of Yale University, the pioneer in agricultural chemistry in this country. Professor Johnson's book is out of print, and his work on peat had been almost forgotten. The forthcoming bulletin will render his important work once more accessible by the republication of the important parts of his book, edited and revised by his friend and pupil, Dr. E. H. Jenkins, Director of the Connecticut Agricultural Experiment Station.

## BULLETINS ACCEPTED FOR PUBLICATION

The following bulletins have been accepted for publication by the Superintendent, but the appropriations hitherto available for printing have sufficed only for the bulletins in the previous lists.

Drainage and Glaciation in the Central Housatonic Basin: by Ruth Sawyer Harvey. This paper is an interesting study of some changes in drainage resulting from the events of the Glacial period.

The Amphipods and Isopods of Connecticut: by Beverly Waugh Kunkel. These are interesting groups of Crustacea, chiefly marine. This paper will be the second instalment of the series on the marine zoölogy of the state, inaugurated by Professor Coe's bulletin on the Echinoderms.

Triassic Life of the Connecticut Valley: by Richard Swann Lull. Professor Lull has made himself eminently an authority on the Dinosaurs, a remarkable group of extinct reptiles whose presence in the Connecticut Valley is attested by a few skeletons and numerous footprints. This paper presents not merely a catalogue of fossil species, but a vivid picture of the life of Triassic times.

Central Connecticut in Geologic Time: by Joseph Barrell. This paper will be of special value to teachers, by reason of its realistic representation of the geographical changes which this region has undergone in the course of geological time.

Check-list of the Insects of Connecticut: by Wilton Everett Britton. As it must be many years before the Guide to the Insects of Connecticut can be finished, it is believed that a check-list will be useful in the meantime.

Glacial Geology of the New Haven Region: by Freeman Ward. A detailed study of the Glacial Geology of a single district. Valuable in itself, and valuable as a contribution to the investigations which are expected eventually to afford material for a general map of the Glacial geology of the state.

The Bacteria of the Fresh Waters of Connecticut: by Herbert William Conn and Lena Raye Potter. This is of great value, being the result of work prosecuted in the laboratory of Wesleyan University continuously for a number of years.

## UNFINISHED WORK

Professor H. E. Gregory and his assistants have done a large amount of field work on the Glacial geology of the state. It is hoped that some of the results of this work will appear at an early date in a bulletin on the Glacial geology of the Naugatuck Valley, and that later the material will be accumulated for a general report with map of the Quaternary of the state. Dr.

F. P. Gulliver's studies of the terraces of the Thames River have added much to our knowledge of some phases of Quaternary history, but are not yet ready for publication. Dr. G. P. Clinton has a bulletin on the Downy Mildews, a group of Fungi very pernicious to agricultural interests, well advanced towards completion. Professor A. E. Verrill has done much work on a bulletin on the Stalk-eyed Crustacea (including a full discussion of the economic relations of the lobster). Dr. W. E. Britton has in hand a third instalment of the Guide to the Insects of Connecticut, relating to the Hemiptera, or bugs and their allies.

## Distribution of the Appropriations

The expenditures for work which has been completed and for which full payment has been made since the last biennial report, have been as follows:—

| Name | Work | Compensation | Expenses |
|---|---|---|---|
| W. N. Rice | Superintendence, 1909-11 | $400.00 | $300.00 |
| F. Ward | Glacial Geology | 192.50 | 54.63 |
| R. S. Lull | Triassic Life of Connecticut Valley | 200.00 | 101.97 |
| H. W. Conn | Bacteria of Fresh Waters | 200.00 | 570.88 |
| B. W. Kunkel | Amphipods and Isopods | 100.00 | 48.00 |
| W. E. Britton | Check-list of Insects | 100.00 | 16.50 |

The allotments for work which is still in progress, or for which full payment has not been made, are as follows:—

| Name | Work | Compensation | Expenses |
|---|---|---|---|
| W. N. Rice | Superintendence, 1911-13 | $400 | $500 |
| F. P. Gulliver | Terraces of Thames River | | 425 |
| H. E. Gregory | Glacial Geology | | 828 |
| C. A. Davis and others | Peat Deposits | | 659 |
| G. P. Clinton | Downy Mildews | 50 | 25 |
| J. H. Sage and L. B. Bishop | Birds | 200 | 400 |
| W. E. Britton and others | Guide to Insects | 525 | 325 |
| A. E. Verrill | Stalk-eyed Crustacea | 150 | 250 |

## Plans for Future Work

### I. *Geology*

It may be said in general that there is need of more detailed study in most parts of the state than has yet been accomplished. The area of the state most thoroughly studied as regards the bed rocks is that of the Triassic formation. The area where detailed work is most lacking as yet is that of the eastern crystallines. The geological work which has been done in much of eastern

Connecticut amounts to little more than a reconnoissance. The Manual of Geology, and the Geological Map by which it is supplemented, bear most eminently the character, not of final reports, but of reports of progress. Their publication was amply justified by the need, on the part of teachers and others, for publications which would set forth in convenient and intelligible form our present knowledge of the geology of the state. But they certainly will require very much of correction in detail. It is, moreover, not unlikely that more detailed study will bring to light facts which will lead to very important changes in the general conception of the geological history which is recorded in our rocks.

The necessity for more detailed study in various parts of the state is even greater in regard to surface geology than in regard to the geology of the underlying rocks. Professor Gregory and Drs. Gulliver, Ward, and Harvey have made a beginning of such investigation; but a vast amount of careful work must be done before we can reach the true history of the Quaternary era in our territory.

A class of geological papers which would be of great educational value would be a series of geological guide-books to various regions of the state. In these guide-books directions sufficiently detailed to be practical should be given for excursions to localities where the most characteristic and instructive geological phenomena could be seen. Professor James D. Dana prepared years ago a book fitted to serve this purpose for the vicinity of New Haven; but even for that region there is need of a guide-book brought down to date, as regards both the scientific interpretation of phenomena and the arrangement of the itinerary. A series of such books for various districts of the state would make the study of geology in the high schools more real and genuine than it can otherwise be.

A report on the mineralogy of our state would be very useful. Lists of American localities of minerals have been published in a number of editions of the works of J. D. and E. S. Dana on mineralogy, the latest being in the sixth edition of the System of Mineralogy, published in 1892. A list of Connecticut minerals by Hattie E. Cochrane, dated 1894, is contained in the Report of the State Board of Education for 1896. Neither of these lists is by any means complete. Moreover, a report of the mineralogy of the state should be much more than a mere list of minerals occurring in the respective towns. Such a report should give more detailed information in regard to localities of interesting and important minerals, and should enter into some discussion of the geological relations of the minerals.

In the introductory chapter of the Manual of Connecticut Geology is found a brief discussion of the physical geography of the state in relation to geological structure. A subject whose treatment in a bulletin or in a series of bulletins would be of great educational value, would be the physical geography of various parts of the state, particularly in relation to human life and history. In such publications, the influence of geographic conditions in the location of towns, in the determination of routes of travel, and in the control of the industries of the state, should be discussed. Such bulletin or bulletins on the physical geography of the state would be of great interest to all intelligent citizens, and particularly to the teachers in our schools.

### *II. Botany*

The labors of the Connecticut Botanical Society have given to us a list of the flowering plants of the state, and of the ferns and their allies. This paper affords much information in regard to the geographical and topographical distribution of particular species of plants. An appropriate line of investigation, and one in regard to which it may be hoped that the Survey may be able to publish important papers in the future, would be the more extended study of the distribution of plants with reference to altitude, geological formation, distance from the sea, temperature, and rainfall, and the grouping of plants into plant societies in different areas — in short, the study of what is now called the ecology of plants.

The systematic botany of the flowering plants has been comparatively well worked out for this region of country. Much less has been done in regard to the flowerless plants, and particularly in regard to the lower classes of flowerless plants. The paper of Professor Evans and Mr. Nichols on the mosses and liverworts, those of Professor White on the larger fungi, those of Dr. Clinton on the microscopic fungi, that of Professor Conn and Mrs. Webster on the fresh-water algæ, and that of Professor Conn on the bacteria, make a good beginning in this direction. But there are a number of groups of the lower flowerless plants for whose study very little material is accessible to students or even to teachers in Connecticut. Interesting groups which should be treated in future bulletins of the Survey are the lichens and the marine algæ.

### *III. Zoölogy*

Professor Conn's paper on the protozoa makes a good beginning of the study of the life of our fresh waters. In future years attention should be given to other groups of fresh-water organisms; for instance, the mollusks, worms, crustacea, and fishes.

No general work dealing with the marine fauna of the Connecticut coast has been published since the very valuable paper by Verrill and Smith on the Invertebrate Animals of Vineyard Sound, published in the Report of the United States Commissioner of Fish and Fisheries for 1871-2.* The State Survey has made a beginning of a series of papers on our marine fauna, in the paper of Professor Coe on the echinoderms, already published, and the papers of Professor Verrill and Dr. Kunkel on the crustacea, of which the former is well advanced towards completion, and the latter has been accepted for publication. Papers on other groups of marine organisms should follow. Some of these papers would be of very great educational value, while some of them would be important from an economic point of view, since our marine fauna includes some species which are among the important resources of the state, and other species which are destructive of important resources.

Of the principal orders of insects, the orthoptera are treated in a bulletin already published, and the hymenoptera in one which has been accepted for publication. A bulletin on the hemiptera is in preparation. Other orders remain to be treated, among which are several of those most numerous in species and most important in economic relations.

A bulletin on the birds of Connecticut is now in press; but the mammals, reptiles, amphibia, and various groups of terrestrial invertebrates await consideration in future years.

## The Continuance of the Survey

What has already been said in regard to the work accomplished or in progress and the plans for future work, makes it obvious that the business of the State Geological and Natural History Survey is not rapidly approaching completion. In fact, the State Survey should be recognized as a permanent institution. The Geological Survey of the state of New York was commenced in 1836. There is at present no organization in the state of New York bearing the title of Geological Survey, but there is a Science Division of the Educational Department of the state, whose staff includes a State Geologist, a State Botanist, a State Entomologist, and a number of other scientific workers. Under one form of organization or another, the work of investigation of the geology and natural history of New York under the auspices of the state has already been substantially continuous for more than two generations. There is no prospect that it will ever be finished.

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*Most of the animals living in Long Island Sound and Fisher's Island Sound are included in the fauna of Vineyard Sound.

In a number of states, indeed, Geological Surveys have been organized, prosecuted for a few years, and concluded by the publication of so-called final reports. But there can be no final report on the geology, the botany, or the zoölogy of any district of country. In those states whose Geological Surveys have published what have been called final reports, enlightened citizens and legislators have sooner or later come to see the necessity for organizing a second, and in some cases a third, Survey, and doing the work over again. The sciences of nature are progressive; new discoveries from time to time put old facts in new relations, and raise new questions whose answer requires new methods of investigation. There are changes also in the arts which depend upon the application of the sciences, as well as in the sciences themselves. New forms of raw material become valuable, new modes of utilizing well-known materials become practicable. On the economic side, as well as on the purely scientific side, arises a necessity that the work of a Survey which had been supposed to be completed should be done over again.

If a State Survey is recognized as a permanent bureau, it can publish, from time to time, supplementary reports correcting and amplifying its previous work as may be necessary. It can be ready also to give attention to particular investigations which may have a special importance, for economic or other reasons, at some particular time. Moreover, the work of a Geological and Natural History Survey can be carried on much more economically by the plan of small appropriations maintaining a permanent organization, than by the plan of attempting to complete the work in a few years and then doing it over again a generation later. Field work can be done in the summer vacations by college professors, teachers, and others who are willing to do a certain amount of such work for very small compensation. Investigations can be made and bulletins can be written in large degree in odds and ends of time, by men who receive salaries for work in the colleges and schools or in museums and other scientific institutions. Under such conditions men of a high grade of ability and attainment are willing to offer for publication the result of their investigations for merely nominal compensation. The amount of valuable material already published, and the amount which is ready or nearly ready for publication, by our Survey, in comparison with the very small cost, is a striking illustration of the economy of this method of procedure. If, on the other hand, the work of a Survey is to be completed, and final reports presented, in a few years, it is generally necessary that a number of competent men should be employed to give practically their whole time to the work. They must be paid salaries which will justify them in resigning any official positions which they may hold and taking their chances of securing other employment when the work of the Survey is finished.

The appropriation for the Connecticut Geological and Natural History Survey is one of the smallest of those which are made by the states at present maintaining such surveys. Six states make annual appropriations for geology alone ranging from ten thousand to twenty-eight thousand dollars, exclusive of cost of publication, and five others make annual appropriations ranging from ten thousand to fifteen thousand dollars, inclusive of cost of publication. In comparison with an appropriation of ten thousand dollars for geology alone, our appropriation of fifteen hundred dollars for geology, botany, and zoölogy seems rather small. It is fair, however, to consider that Connecticut is not a large state, and that there is no probability that further geological exploration will develop great mineral wealth or create a great mining industry. While a moderate permanent increase of the appropriation would be desirable, the experience of our Survey has shown that creditable and useful work can be done with a small appropriation. The Survey should be recognized as having passed the experimental stage and having vindicated its claim to be a permanent institution.

## Plans for the Next Two Years and Appropriations Desired

However useful the kinds of work outlined above, in Geology, Botany, and Zoölogy, may be, it is the judgment of the Commissioners that they should be postponed for the present, in order that the investigation of the water resources may be pushed forward as rapidly as possible. It is obvious that the sooner the work of surveying the water resources can be completed the greater will be its utility. The United States Geological Survey is willing to continue the same sort of coöperative agreement which has been in force for the past two years. The amount of money which they are willing to allot to the work in Connecticut will depend upon the amount of the appropriation made by Congress in its present session. It is almost certain, however, that the United States Geological Survey will be able to make at least as large an appropriation for the next two years as for the past two years. Two years ago the officers of the United States Geological Survey would have been willing to make a considerably larger appropriation for work in the state of Connecticut if we had been able to duplicate it. Whether they will be able, in view of present demands in other parts of the country, to increase the allotment to Connecticut, cannot be known till the appropriations have been made. The Commissioners of the State Survey are of the opinion that we ought to offer for the ensuing biennial term a larger appropriation than the former one, on condition that the United States Survey be able to duplicate it.

We accordingly earnestly petition the General Assembly to appropriate, for the ensuing biennial term, $1,000 for administrative and miscellaneous expenses, and $3,500, or such part of that sum as the United States Geological Survey may be able to duplicate, for coöperative work in the investigation of water resources.

In accordance with this plan, it is proposed that no new work on the general lines of geology, botany, or zoölogy be commenced during the ensuing biennial term. Work which has been commenced will be pushed forward towards completion as rapidly as possible, and bulletins which have been or which may be completed will be published as speedily as practicable. The appropriation of $1,000 for administrative and miscellaneous expenses will pay the salary of the Superintendent, and necessary traveling and incidental expenses; and will also allow, in some cases in which it may be necessary, small additional payments for work which has been undertaken, for which the allotment originally made proves to be inadequate.

The General Assembly of 1911 granted the petition of the Commissioners of the State Survey for an amendment to the law in regard to the printing of public documents, authorizing, in the case of the general and special reports of the State Survey, the printing of such numbers of copies as the Board of Control may determine, not exceeding 4500. This amendment to the law in regard to public printing carries out the intent of the act by which the Survey was established; which obviously contemplated the printing of the general and special reports of the State Survey, from the funds available for the printing of public documents in general. We, therefore, ask for no special appropriation for publication for the ensuing biennial term.

# Geological and Natural History Survey
## of Connecticut.

### ABSTRACT OF FIFTH BIENNIAL REPORT.

During the past two years no new work has been undertaken excepting an investigation of the water resources of the State, carried on in coöperation with the United States Geological Survey. It seemed desirable for many reasons to enter upon that investigation at the present time. The United States Geological Survey was ready to coöperate in such investigation, appropriating from the United States Treasury an amount equal to that which was appropriated from the State Treasury. In the two years ending June 30, 1913, four thousand dollars ($4,000) will have been expended on that work; two thousand dollars from the State of Connecticut, and two thousand dollars from the United States. It has seemed specially desirable to prosecute that investigation at present, since, in recent years, most of the large towns in Connecticut have been threatened with water famine. The necessary consumption of water for domestic and manufacturing purposes is rapidly increasing. The available supply of coal tends to exhaustion, and the diminished supply must mean in the near future a considerable increase in cost. It is evident, then, that in the near future our manufacturing industries must be forced to depend more largely upon water power. It is believed, also, that irrigation is destined to play a large part in the future development of the agriculture of the State of Connecticut. The average rainfall in Connecticut is, indeed, sufficient for agricultural use; but our farmers often suffer heavy losses from occasional drouth, and these losses might be averted by judicious provision for irrigation. In view of the growing demands upon our water supply there is evident need of a thorough study of that supply. This must include the gaging of the streams for a few years, the construction of profiles of the streams, and also the study of the distribution of underground water.

The Commissioners of the State Survey, accordingly, directed the Superintendent to enter into a contract with the Director of the United States Geological Survey for the conduct of a coöperative investigation of our water resources. By the terms of the contract, that investigation is carried on under the auspices of the United States Geological Survey. The work has been placed under the charge of Professor Herbert E. Gregory, of Yale University.

While it has been deemed best temporarily to concentrate attention upon the water investigation, it should not be forgotten that the scope of the Survey is far more extensive. The Act of 1903 establishing the Survey proposes two subjects for investigation, viz., the Geology of the State, and the Natural History, or Botany and Zoölogy, of the State. The law proposes distinctly three aims with reference to which the work should be prosecuted; first, the scientific aim of advancing our knowledge of the Geology and Natural History of the State; second, the economic aim of leading to the most effective conservation and utilization of its resources; third, the educational aim of helping the work of the schools by furnishing the results of investigation in form adapted for the use of teachers.

The Survey has already published the following Bulletins:

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903–1904.
2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by H. W. Conn.
3. A Preliminary Report on the Hymeniales of Connecticut: by E. A. White.
4. The Clays and Clay Industries of Connecticut: by G. F. Loughlin.
5. The Ustilagineæ, or Smuts, of Connecticut: by G. P. Clinton.
6. Manual of the Geology of Connecticut: by W. N. Rice and H. E. Gregory.
7. Preliminary Geological Map of Connecticut: by H. E. Gregory and H. H. Robinson.
8. Bibliography of Connecticut Geology: by H. E. Gregory.
9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905–1906.
10. A Preliminary Report on the Algæ of the Fresh Waters of Connecticut: by H. W. Conn and L. W. (Hazen) Webster.
11. The Bryophytes of Connecticut: by A. W. Evans and G. E. Nichols.
12. Third Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1907–1908.
13. The Lithology of Connecticut: by J. Barrell and G. F. Loughlin.
14. Catalogue of the Flowering Plants and Ferns of Connecticut growing without cultivation: by a Committee of the Connecticut Botanical Society.
15. Second Report on the Hymeniales of Connecticut: by E. A. White.
16. Guide to the Insects of Connecticut: prepared under the direction of W. E. Britton. Part I., General Introduction: by W. E. Britton. Part II., The Euplexoptera and Orthoptera of Connecticut: by B. H. Walden.
17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909–1910.
18. Triassic Fishes of Connecticut: by C. R. Eastman.
19. Echinoderms of Connecticut: by W. R. Coe.

Four of these Bulletins, Numbers 13, 16, 18, and 19, have been published during the past two years.

The Bulletin on the Lithology of Connecticut includes a general introduction to Lithology and the description of forty-one types of rocks found in Connecticut. Suites of illustrative specimens have been distributed to Colleges, High Schools, and Academies, in the state.

Bulletin 16 is the first instalment of a work which it is proposed to carry on to completion in future years, on the

Insects of Connecticut. The group of Orthoptera treated in the present Bulletin includes insects of great economic importance, the grasshopper and locust being among the worst destroyers of agricultural products.

The Bulletin on the Triassic fishes of Connecticut is of great scientific value, giving the result of a most thorough study of those interesting fossils, and of the evidence which they afford in regard to the age of the sandstones in the Connecticut Valley.

The Bulletin on Echinoderms is beautifully illustrated, and will be of great educational value. It deals with one of the most interesting groups of marine animals. In this class is included the starfish, which is of great economic importance by reason of its ravages to the Oyster industry.

One Bulletin is now in press, and two others have been approved for publication by the Board of Control. These are the following:

The Birds of Connecticut: by J. H. Sage and L. B. Bishop, assisted by W. P. Bliss.
Guide to the Insects of Connecticut; prepared under the direction of W. E. Britton. Part III. The Hymenoptera of Connecticut: by H. L. Viereck.
The Peat Deposits of Connecticut: by C. A. Davis.

The Bulletin on The Birds of Connecticut will be of very great importance both economically and educationally. It contains the results of a vast amount of observation by Messrs. Sage and Bishop, on the occurrence, migrations, and breeding habits of the birds which reside in Connecticut, or visit the State periodically or occasionally in their migrations. The chapter on Economic Ornithology will put in clear light the relations of our birds to the agriculture of the State.

The Bulletin on the Hymenoptera, forming the second instalment of the great work on the Insects of the State, deals with the bees, ants, wasps, ichneumons, gall-flies, and saw-flies. Among these interesting groups are many insects destructive of agricultural products, and others which are agriculturally useful by destroying pernicious insects.

The Bulletin on our Peat Deposits will include a general treatise on the scientific and economic relations of peat, a special description of the peat bogs of Connecticut, and a record of analyses of a large number of samples of Connecticut peat made in the laboratory of the United States Geological Survey. The economic value of peat has been emphasized by recent investigations of the United States Geological Survey, showing its special fitness for use in the gas-producer.

The following Bulletins have been accepted for publication, and will be issued as speedily as may be practicable:

Drainage and Glaciation in the Housatonic Valley: by R. S. Harvey.
The Amphipods and Isopods of Connecticut: by B. W. Kunkel.
Triassic Life of the Connecticut Valley: by R. S. Lull.

Central Connecticut in Geologic Time: by J. Barrell.
Check List of the Insects of Connecticut: by W. E. Britton.
Glacial Geology of the New Haven Region: by F. Ward.
The Bacteria of the Fresh Waters of Connecticut: by H. W. Conn and L. R. Potter.

While it is believed that the work already done or in progress furnishes ample justification of the appropriations which have been made, this work is only a beginning of what the State Survey should accomplish. The geological study of a large part of the area of the state has been little more than a reconnoissance. There is call for a great deal of detailed study, especially in regard to surface geology. A series of guidebooks to interesting geological localities in various parts of the state would be of great utility especially to teachers. A report on the mineralogy of the state would be very useful. The relation of the physical geography of the state to its social, political, and industrial history might well be the subject of a bulletin, or a series of bulletins. While the botany of the flowering plants and some of the higher groups of flowerless plants has been pretty thoroughly studied, much work remains to be done on a number of the lower classes of flowerless plants. The animals of the fresh waters and the salt waters of the state should form the subject of a long series of bulletins. Two important orders of insects have been treated in bulletins, one of which is in press and the other of which has been accepted for publication. But a number of other orders of insects remain to be treated, including many forms of great economic importance.

However important may be the plans of work above indicated, it is deemed wise that they should be postponed for the present, in order that the investigation of the water resources may be pushed forward as speedily as possible. The sooner this water investigation can be completed, the greater will be its utility. The United States Geological Survey is willing to continue the coöperative arrangement which has existed for the past two years. It is practically certain that the United States Geological Survey will be able to make at least as large an appropriation for the next two years as for the past two years. There is reason to hope that the United States Geological Survey will be willing to allot to Connecticut a somewhat larger sum if the state will duplicate it. We, accordingly, earnestly petition the General Assembly to appropriate for the ensuing biennial term one thousand dollars ($1,000) for administrative and miscellaneous expenses, and thirty-five hundred dollars ($3,500), or such part of that sum as the United States Geological Survey may be able to duplicate, for coöperative work in the investigation of water supplies.

The amendment of the law in regard to the printing of public documents, adopted by the General Assembly of 1911, renders unnecessary any special appropriation for publication for the ensuing biennial term.

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